

Analysis of Brain Trauma Coded as a Diffuse Axonal Injury

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Methods

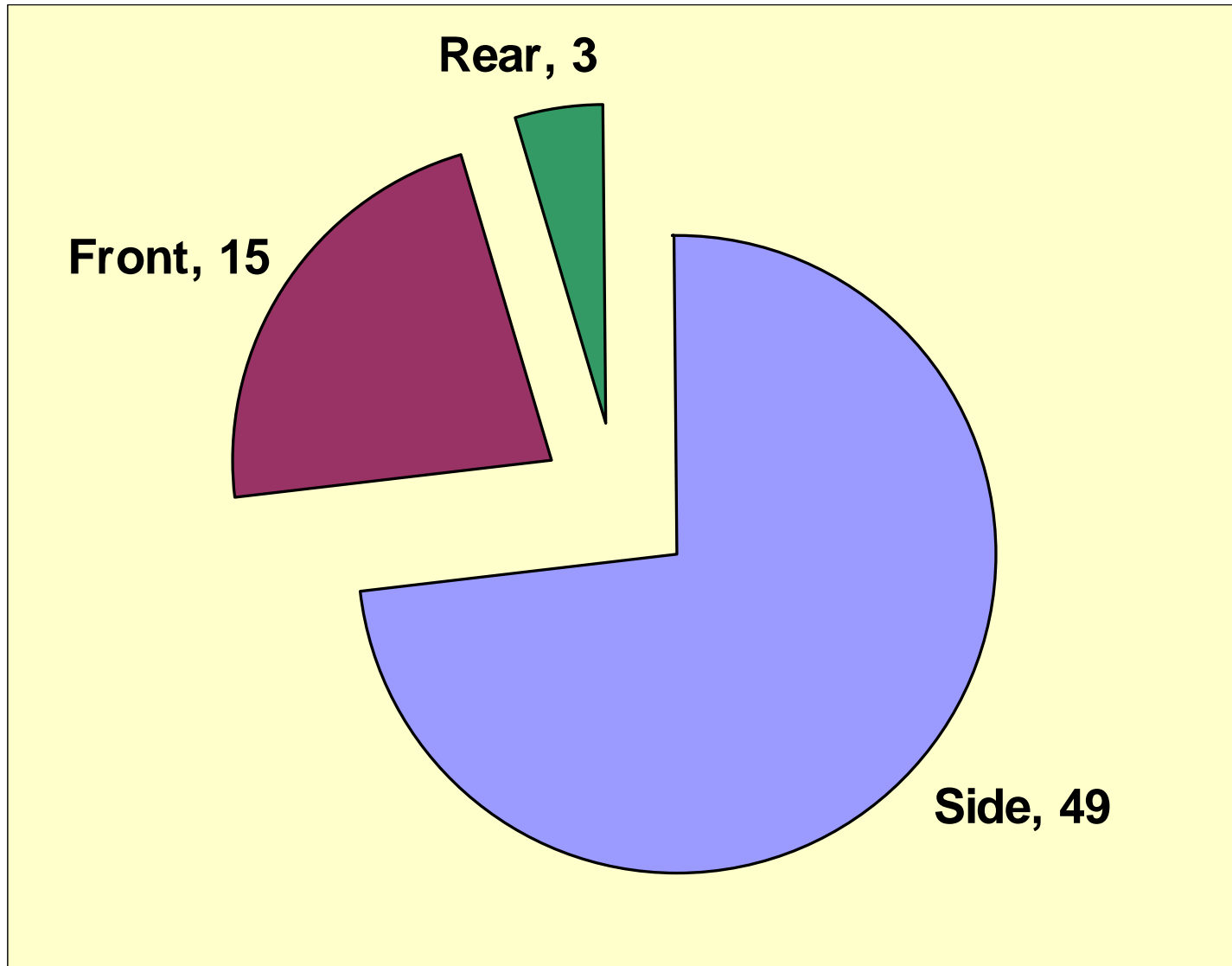
- CIREN 1997 – 2006
- Coded phrase: DAI
- NASS / AIS coding
- AIS 1990+ scheme
- All restraint systems
- All impact modalities
- All occupant positions
- No ejections, rollovers
- Synthesize individual cases



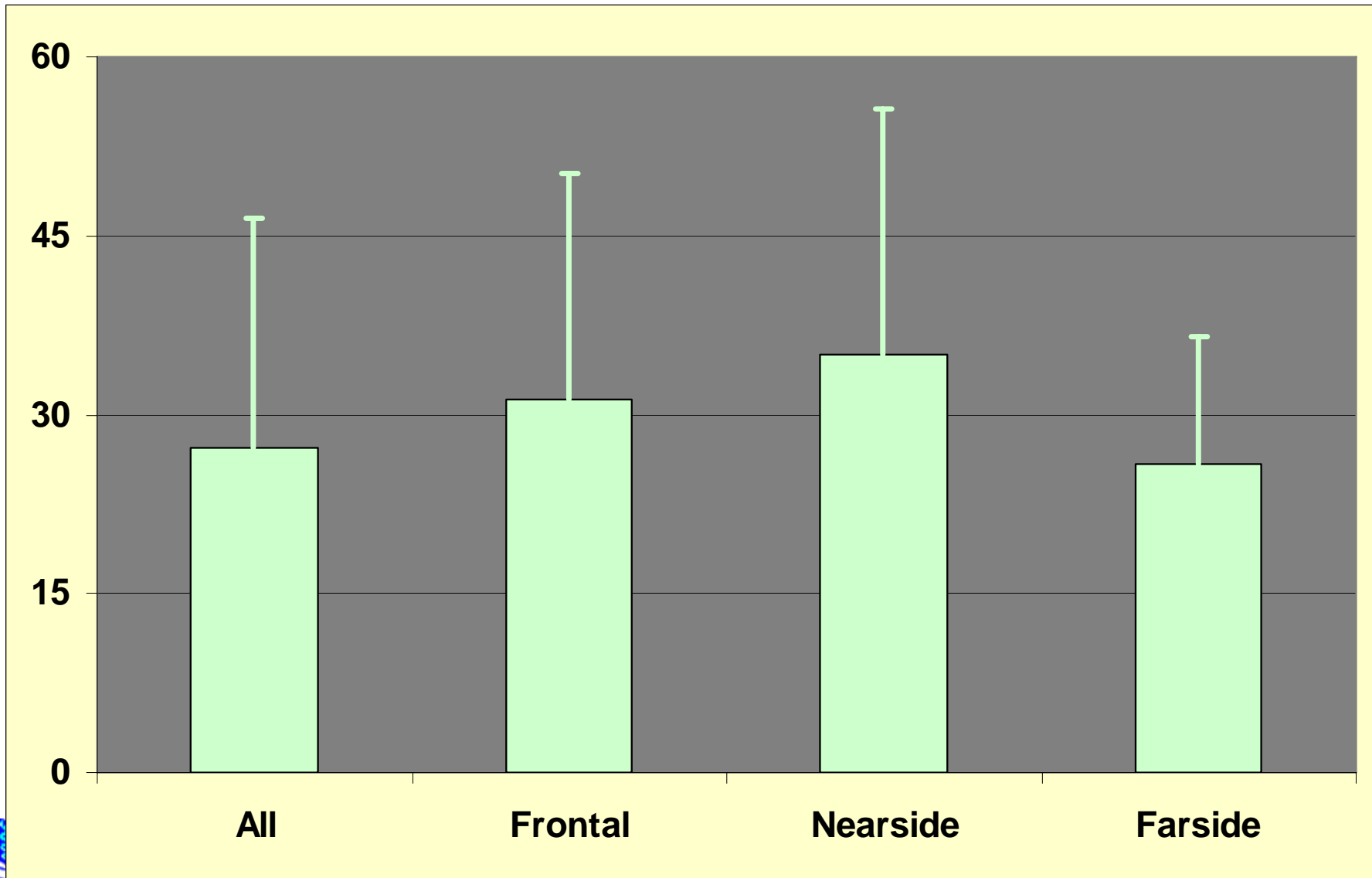
Results

- **2,823 crash cases**
- **3,178 medical cases**
- **67 occupants (2.4%)**
- **One to 85 years of age**
- **53 survivors, 14 fatalities**
- **41 drivers, 26 passengers**
- **15 pediatric, 52 adult occupants**

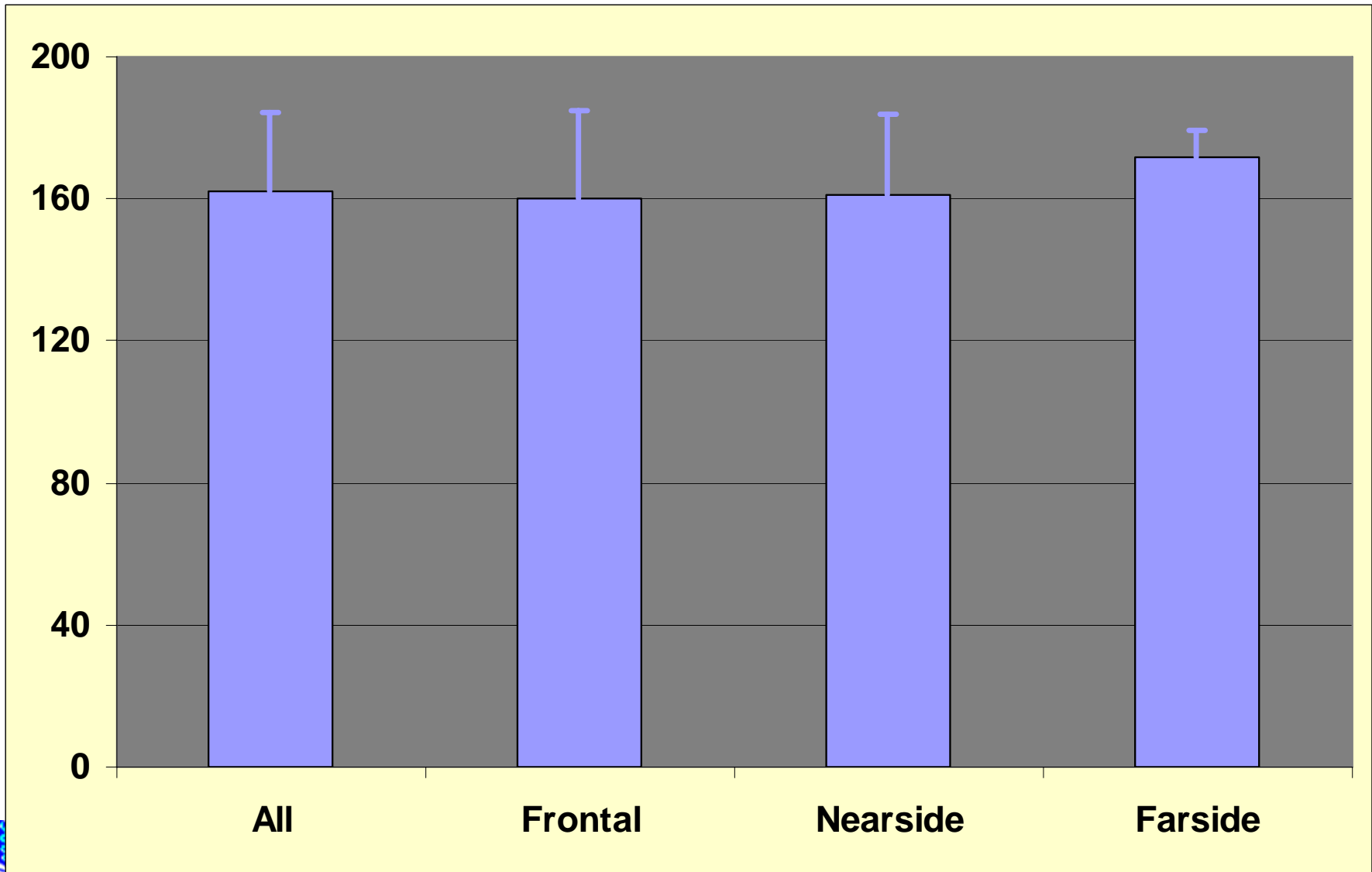
Impact Type



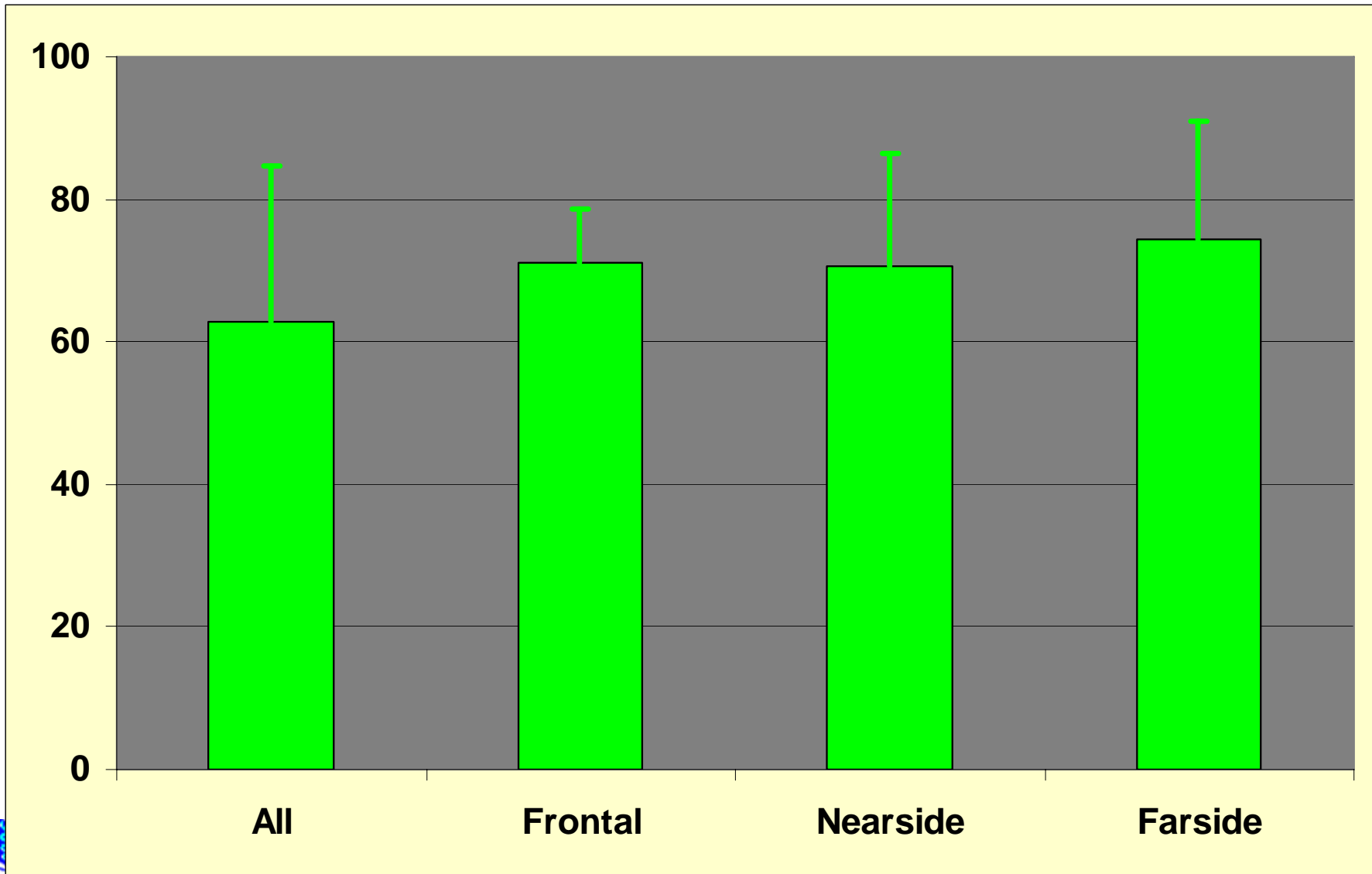
Adult Age Distribution (years)



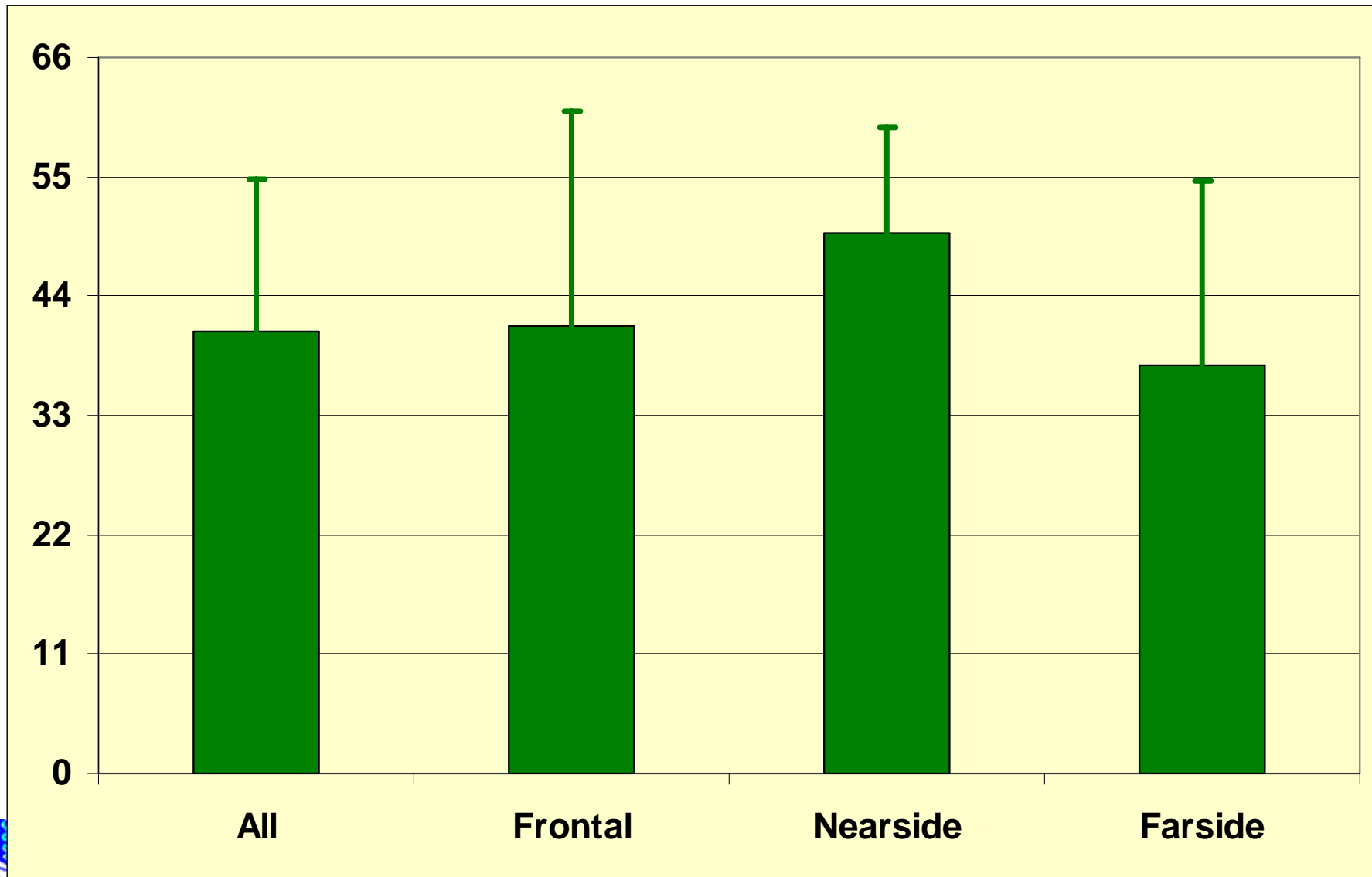
Adult Height Distribution (cm)



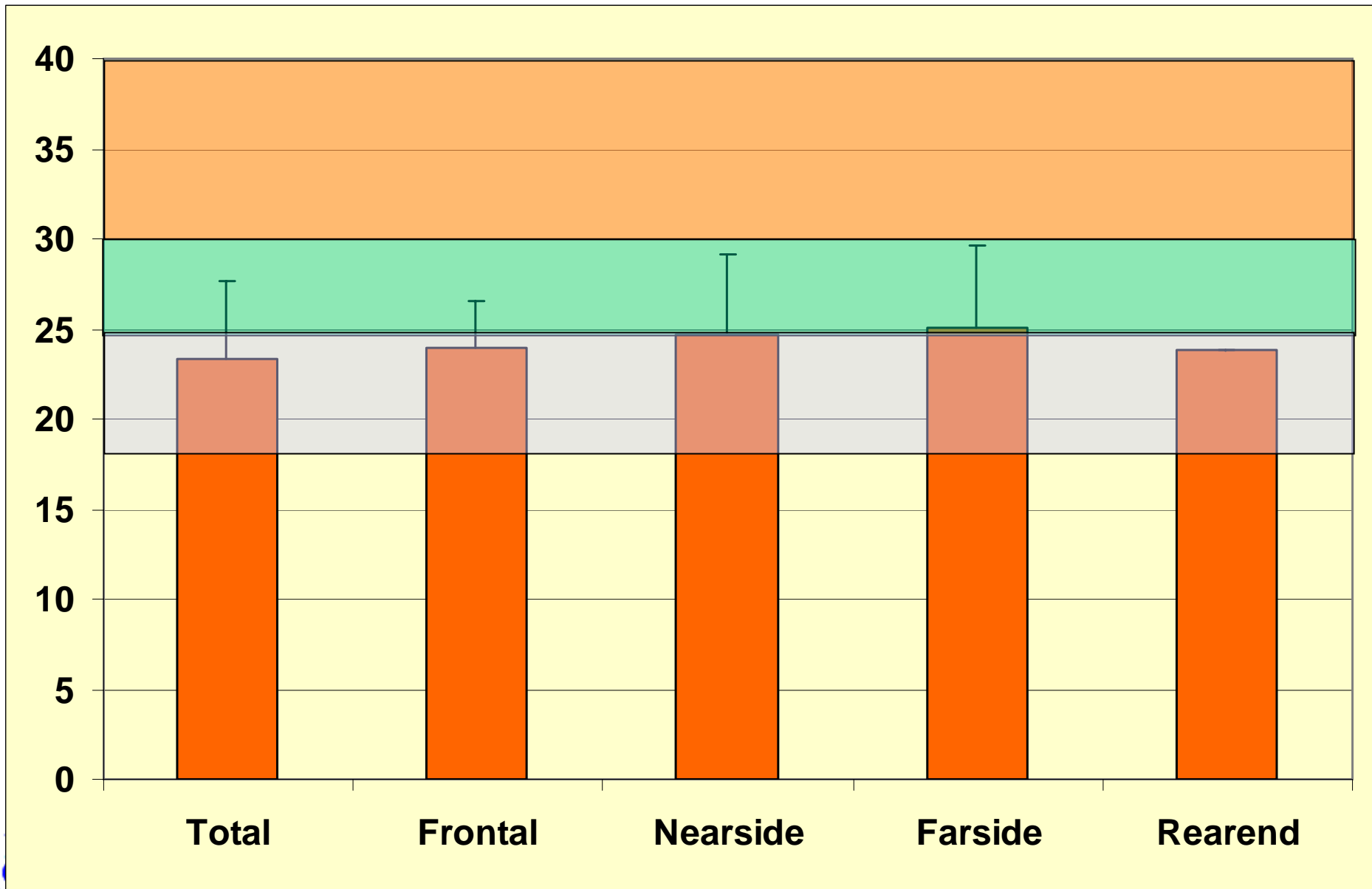
Adult Weight Distribution (kg)



Delta-V Distribution (km/h)



Body Mass Index (kg/m²)



Injury Details

Coded as: Brainstem DAI

Cerebellum DAI

Cerebrum DAI

Cerebrum contusion

Cerebrum hematoma/laceration

Brainstem hemorrhage or swelling

Subarachnoid or subdural hematoma

Cranial vault fracture

Basilar skull fracture

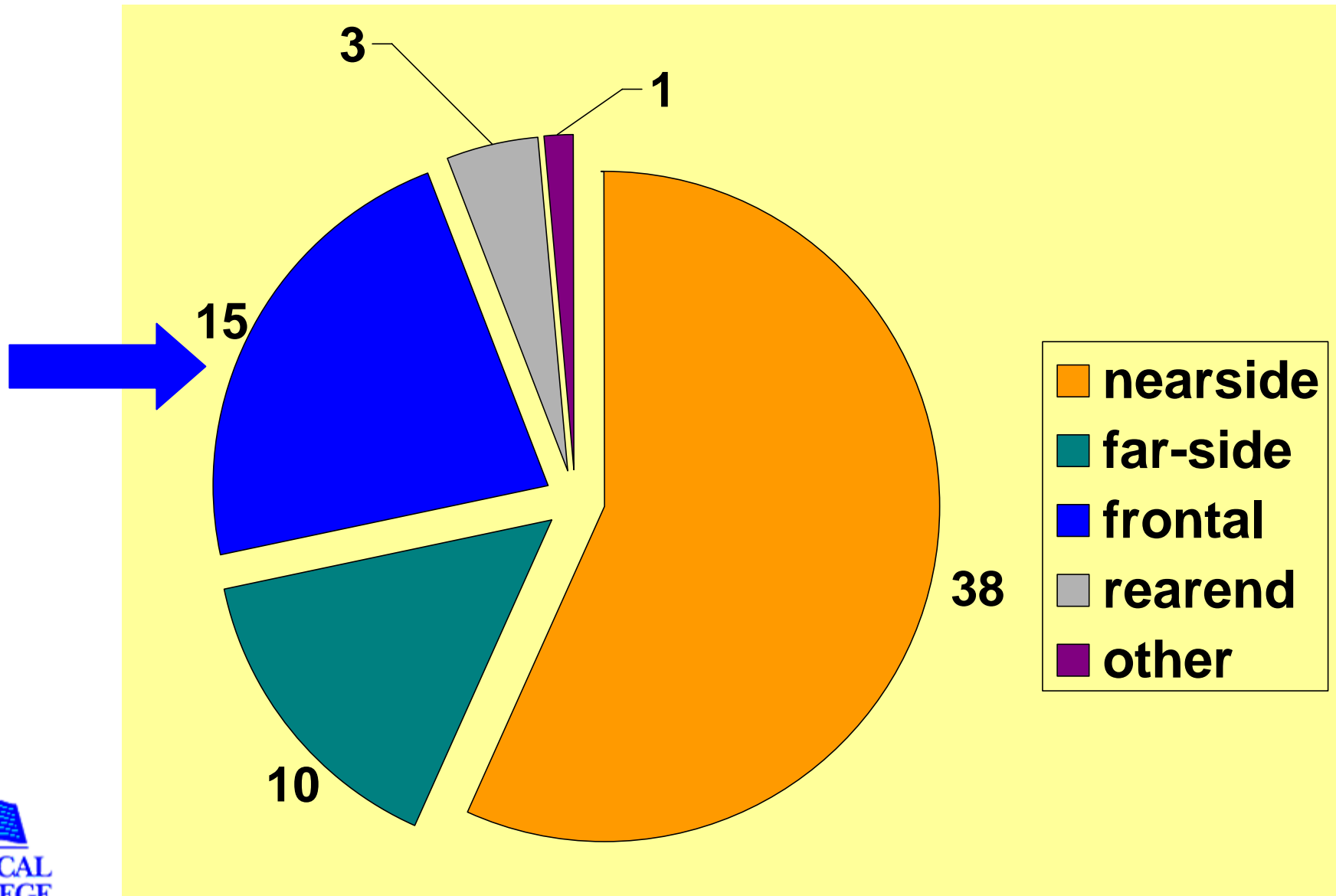
Facial fracture (orbit, zygoma, mandible, ...)

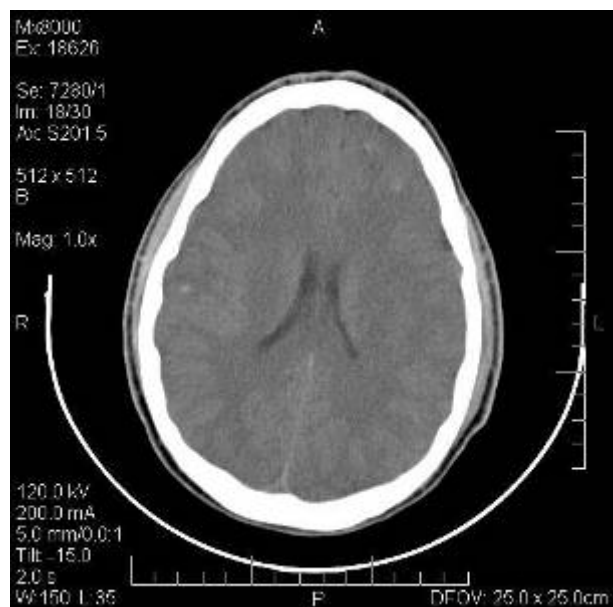
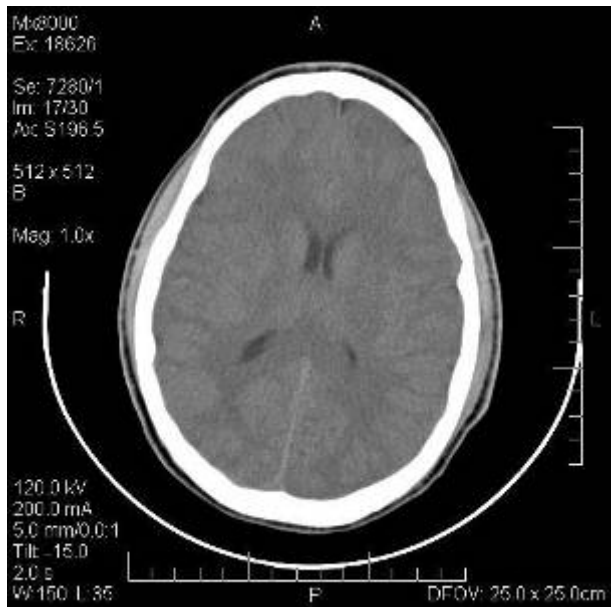
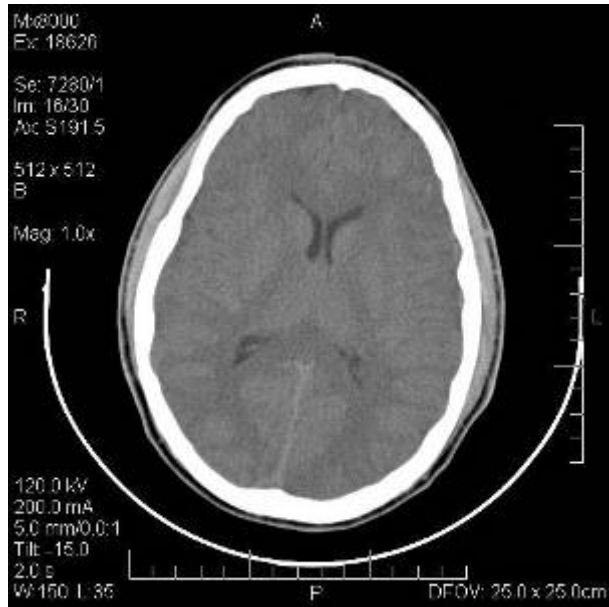
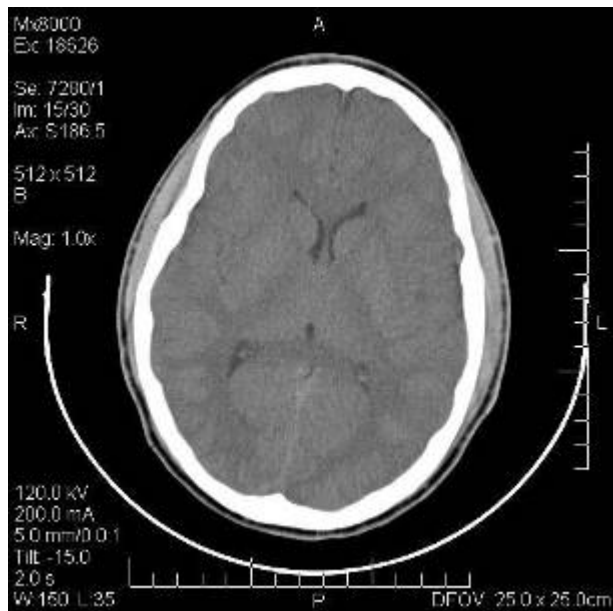
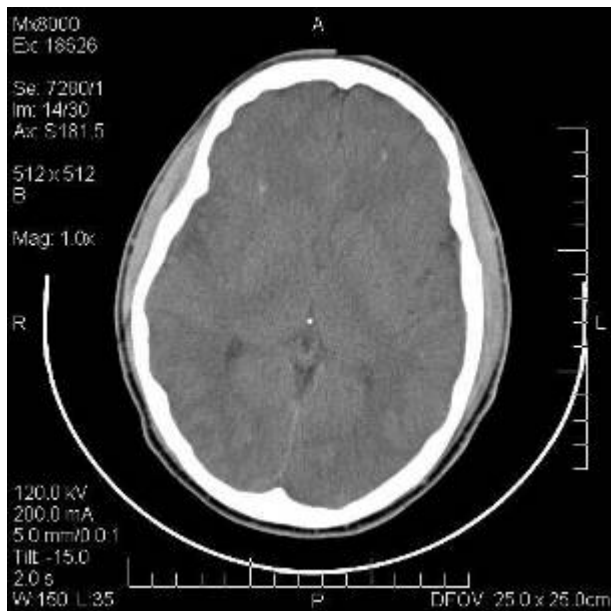
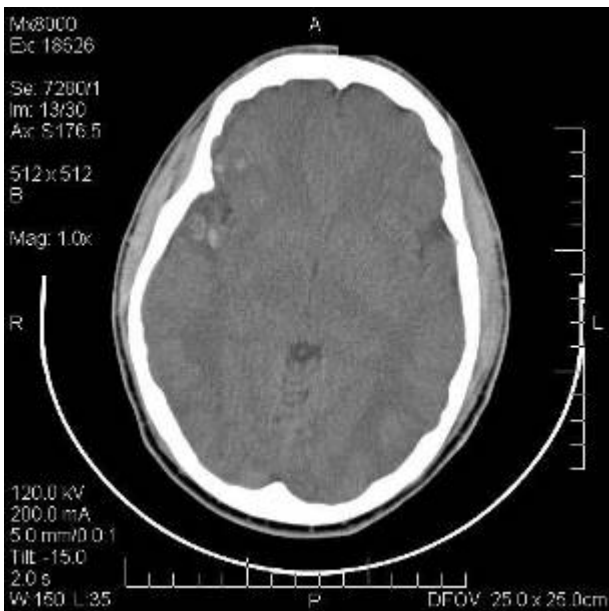
Cervical spine trauma (fracture, dislocation, ...)

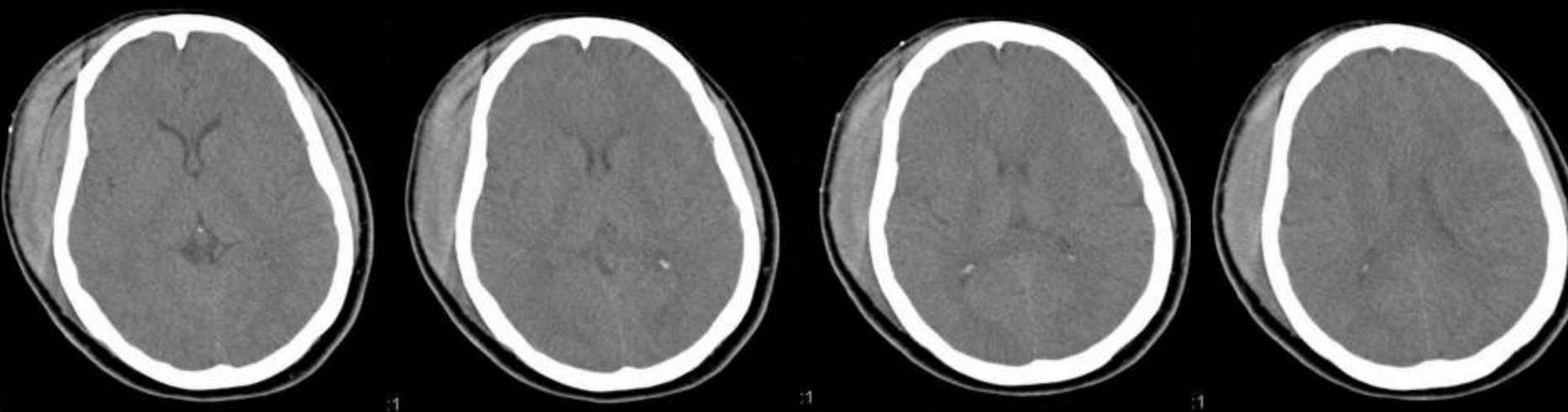
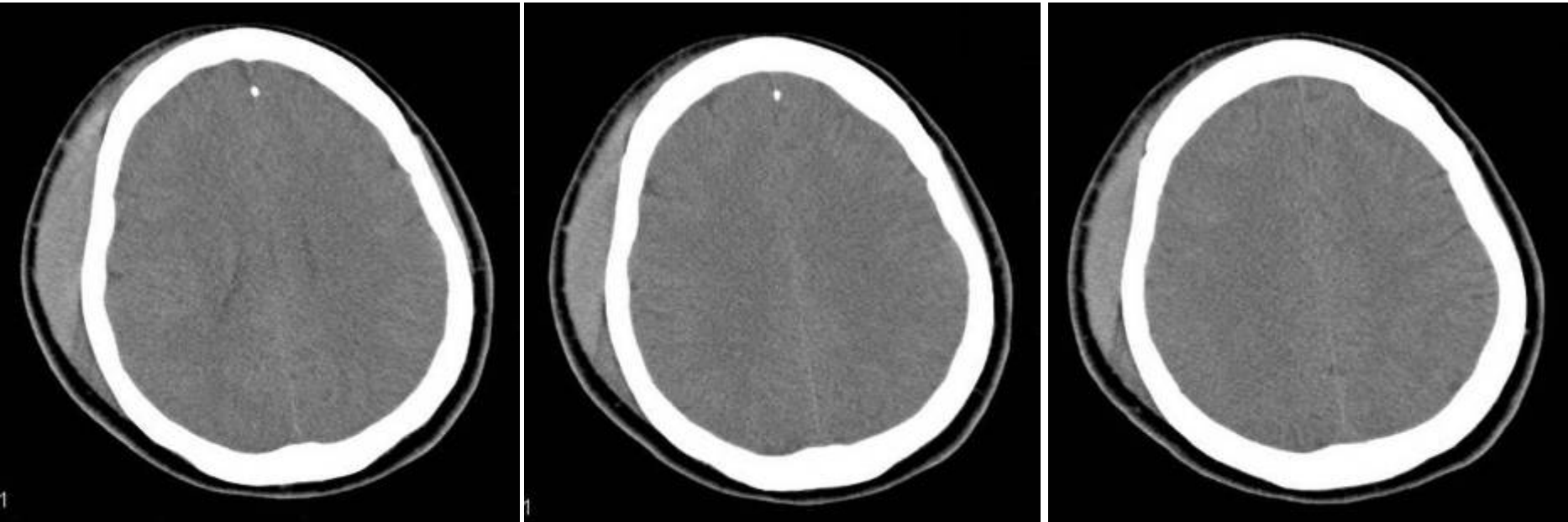
Scalp or facial laceration, abrasion, contusion

LOC ??

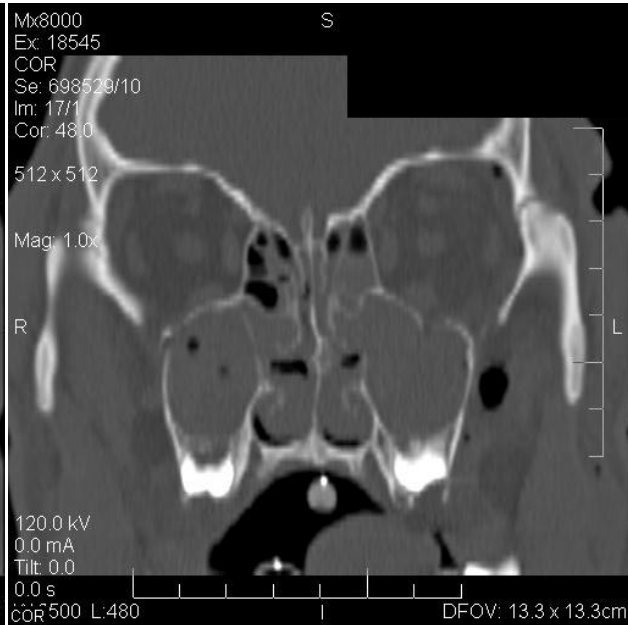
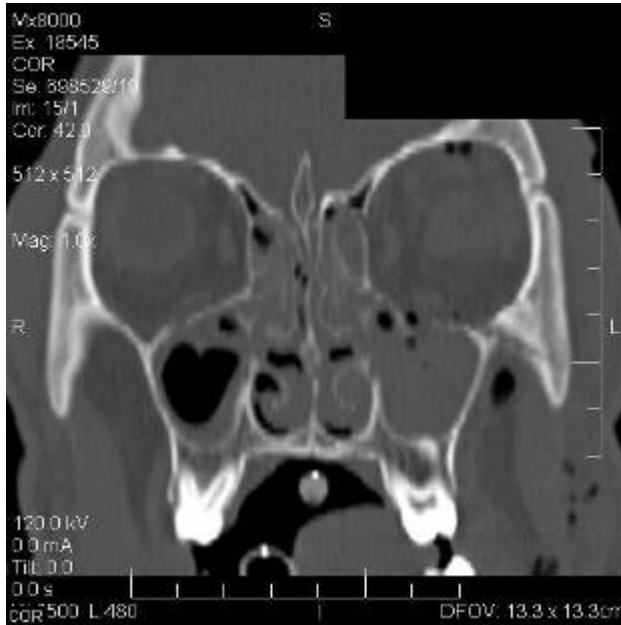
Impact Type



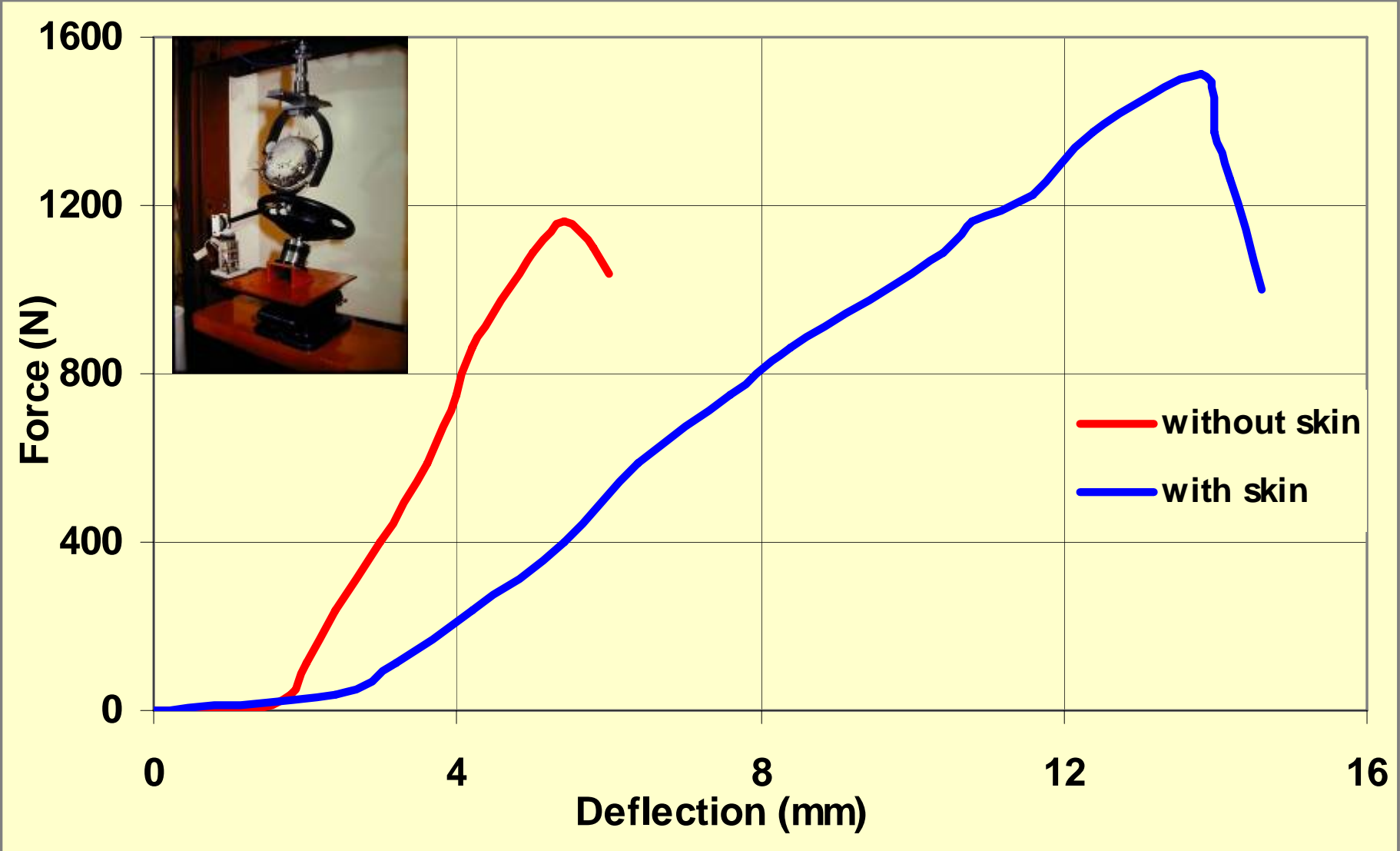




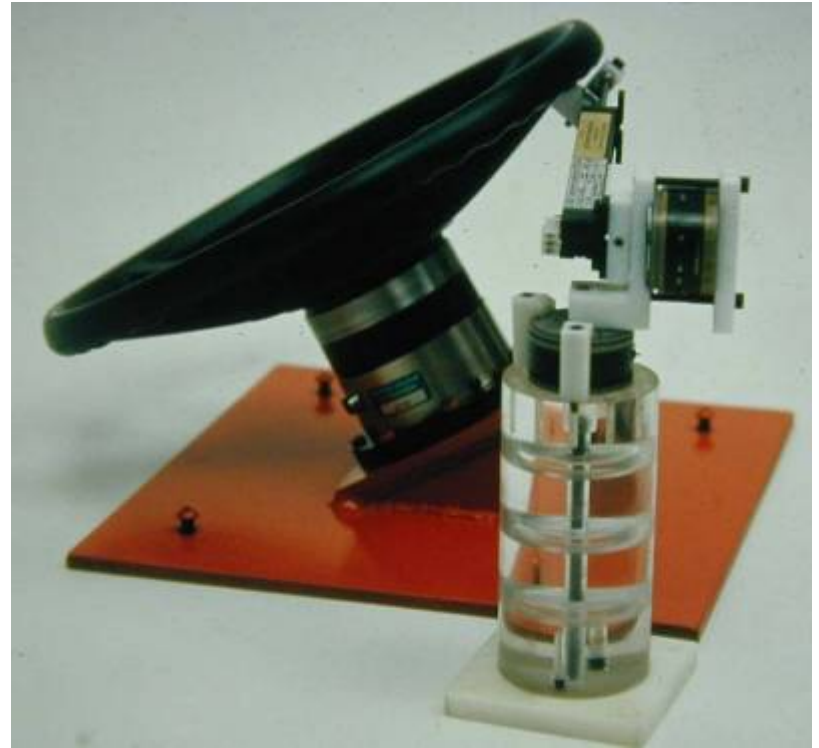
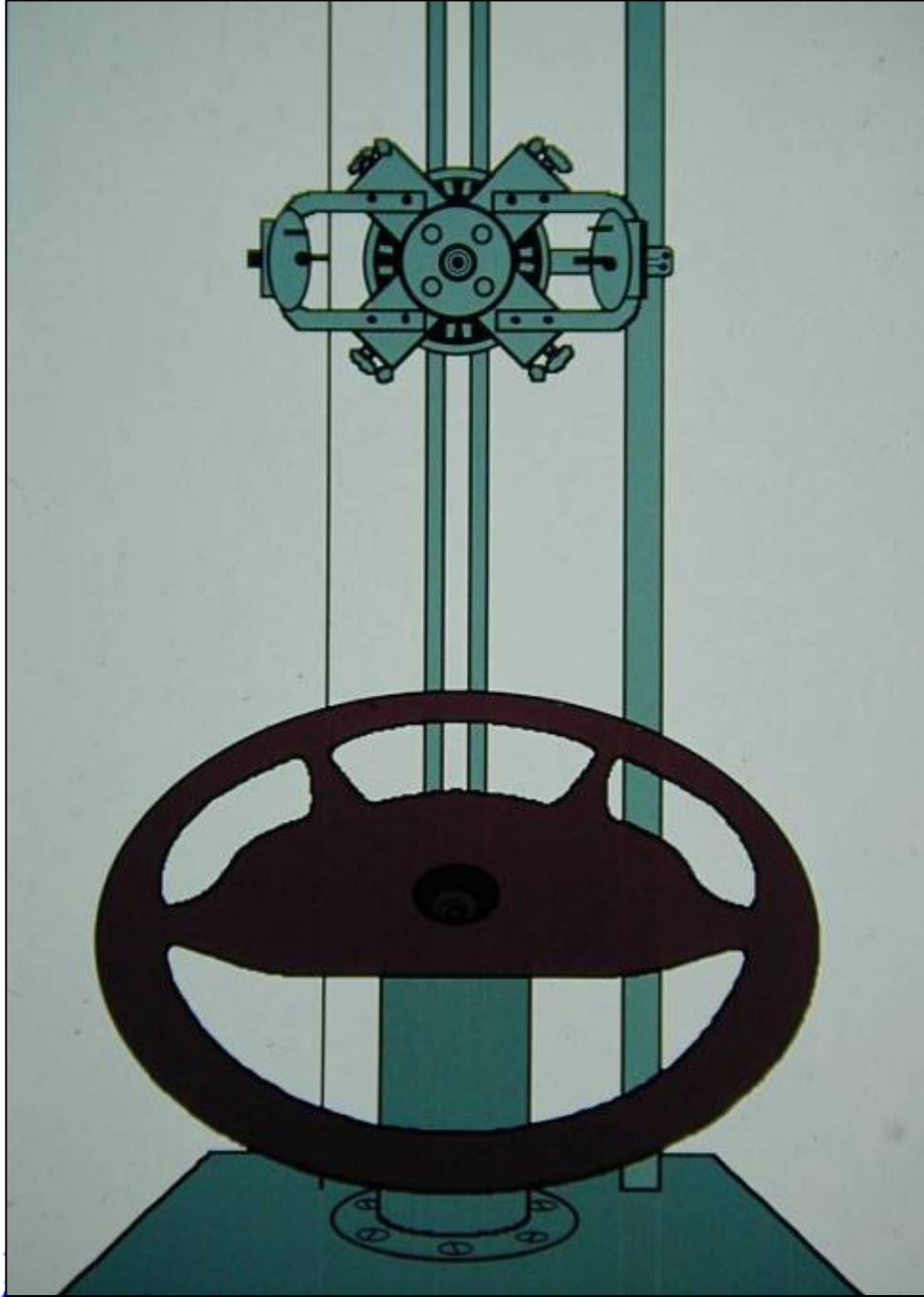
Associated Injuries

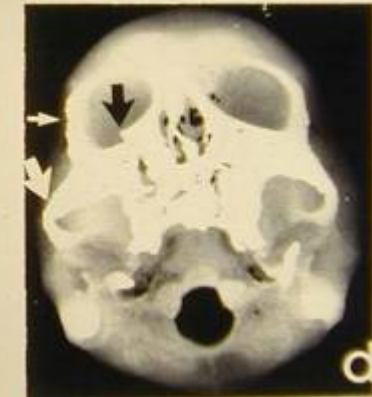
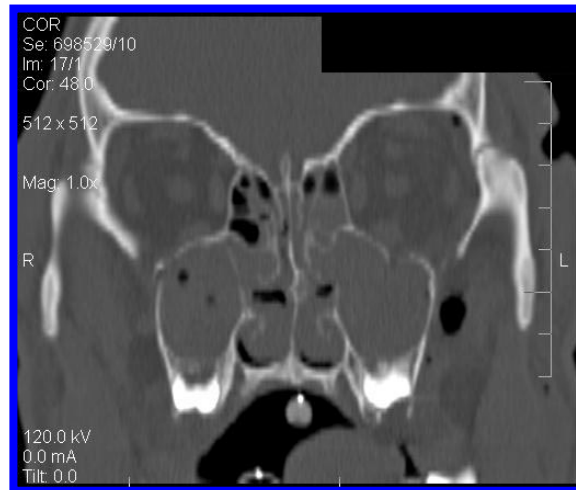
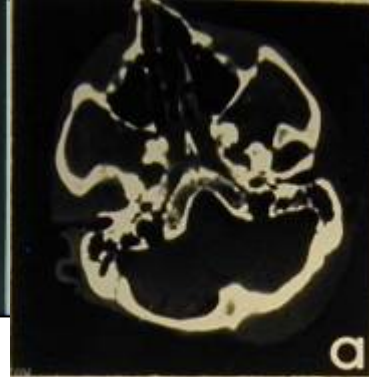
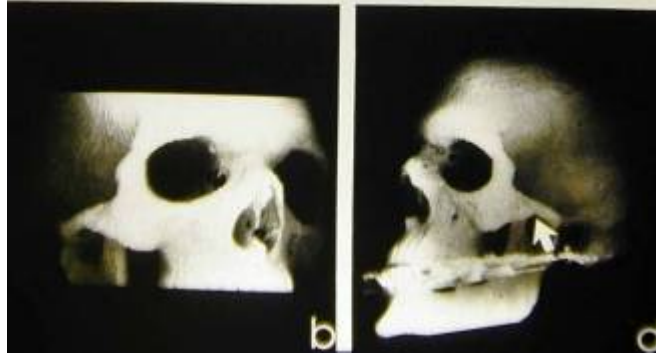


Quasistatic Loading Human Zygoma

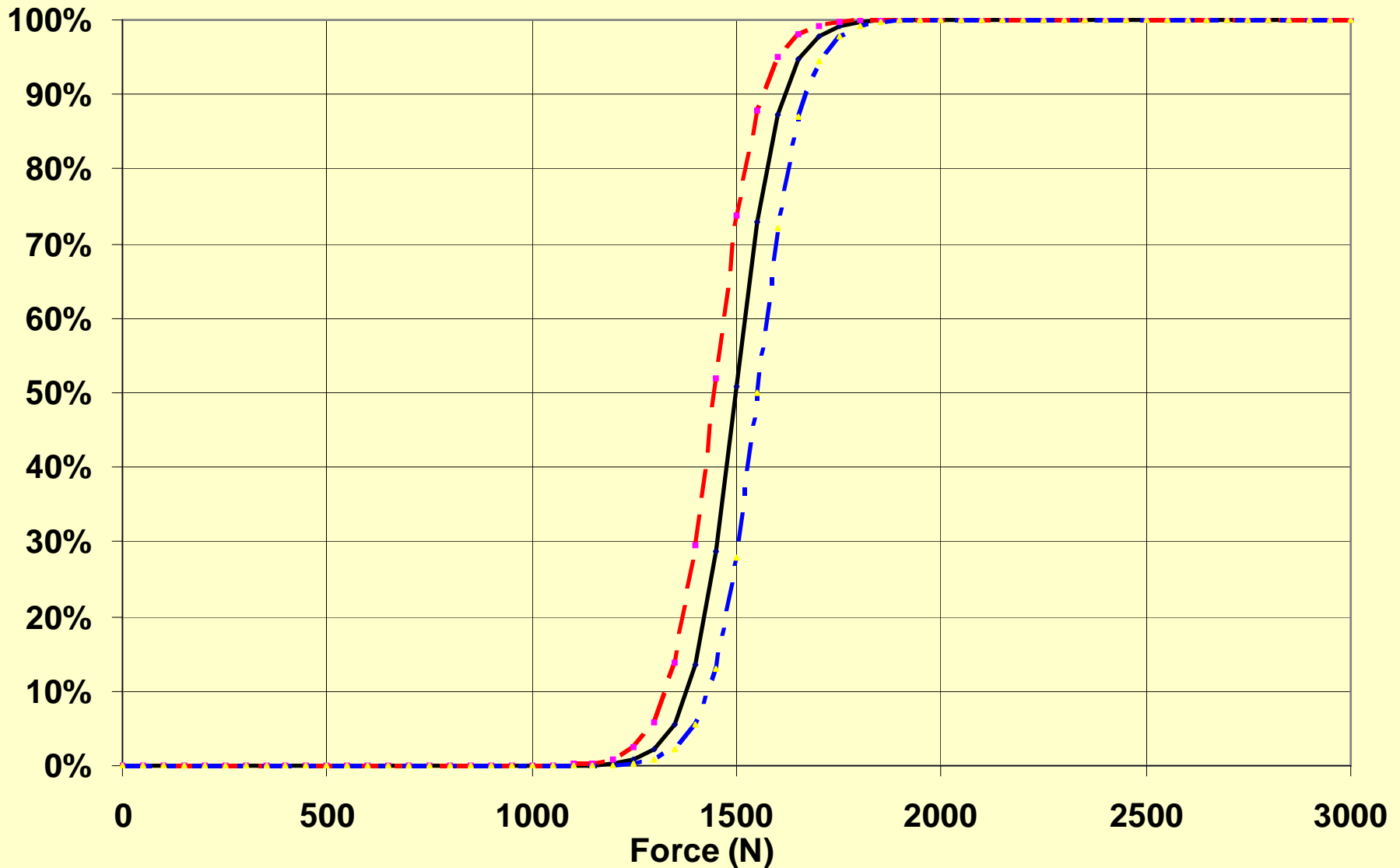


Dynamic Loading

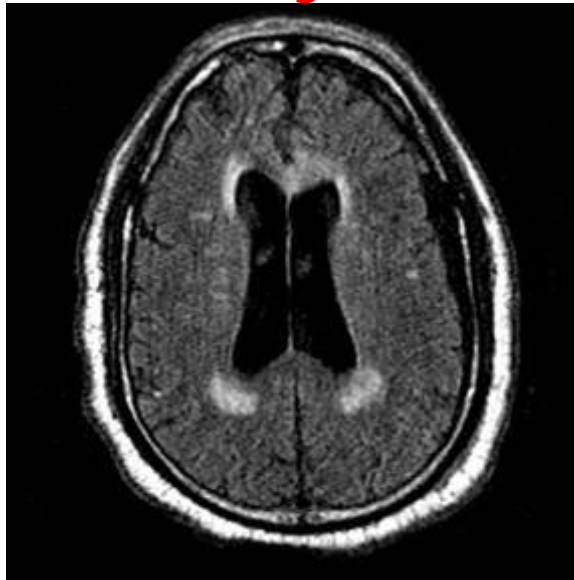
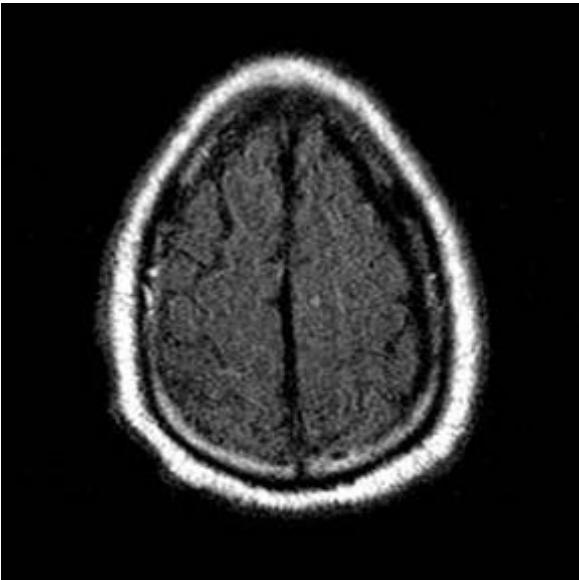




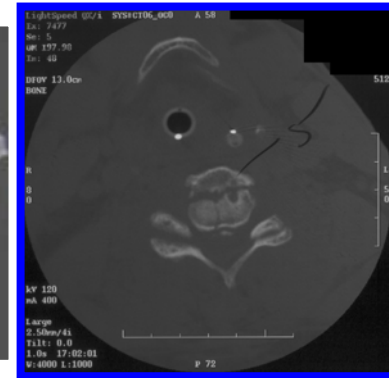
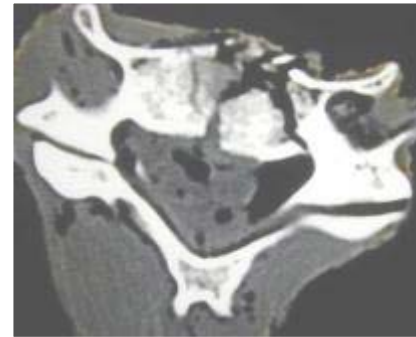
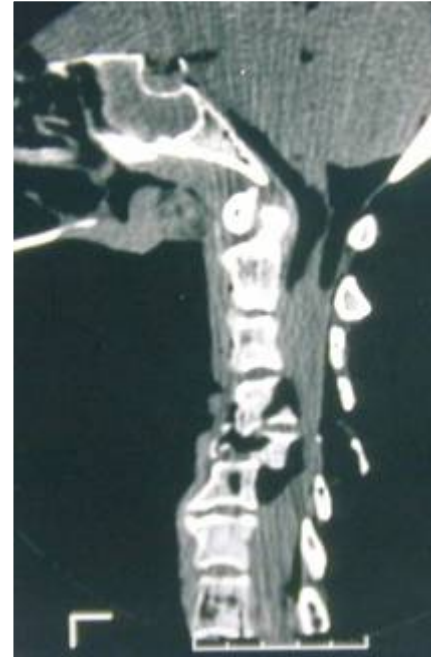
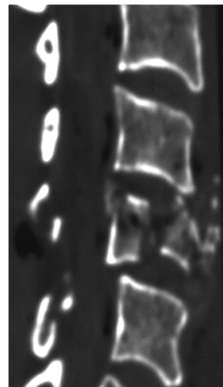
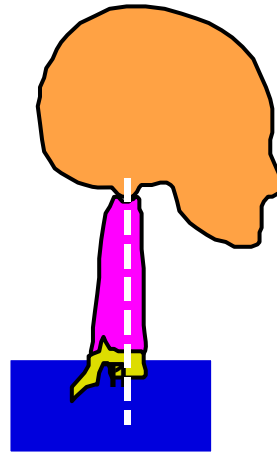
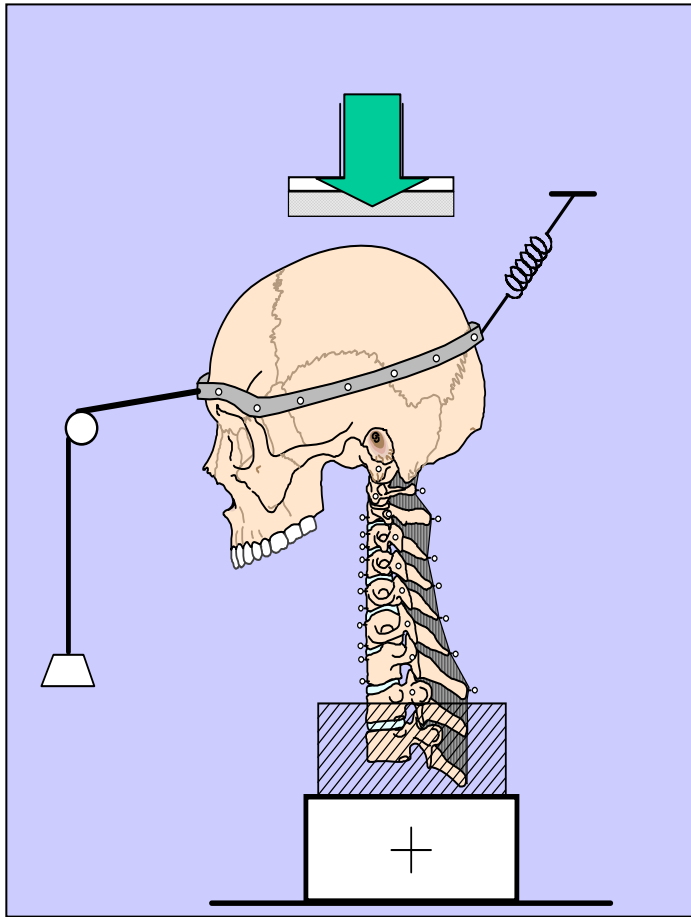
Human Facial Fracture Probability



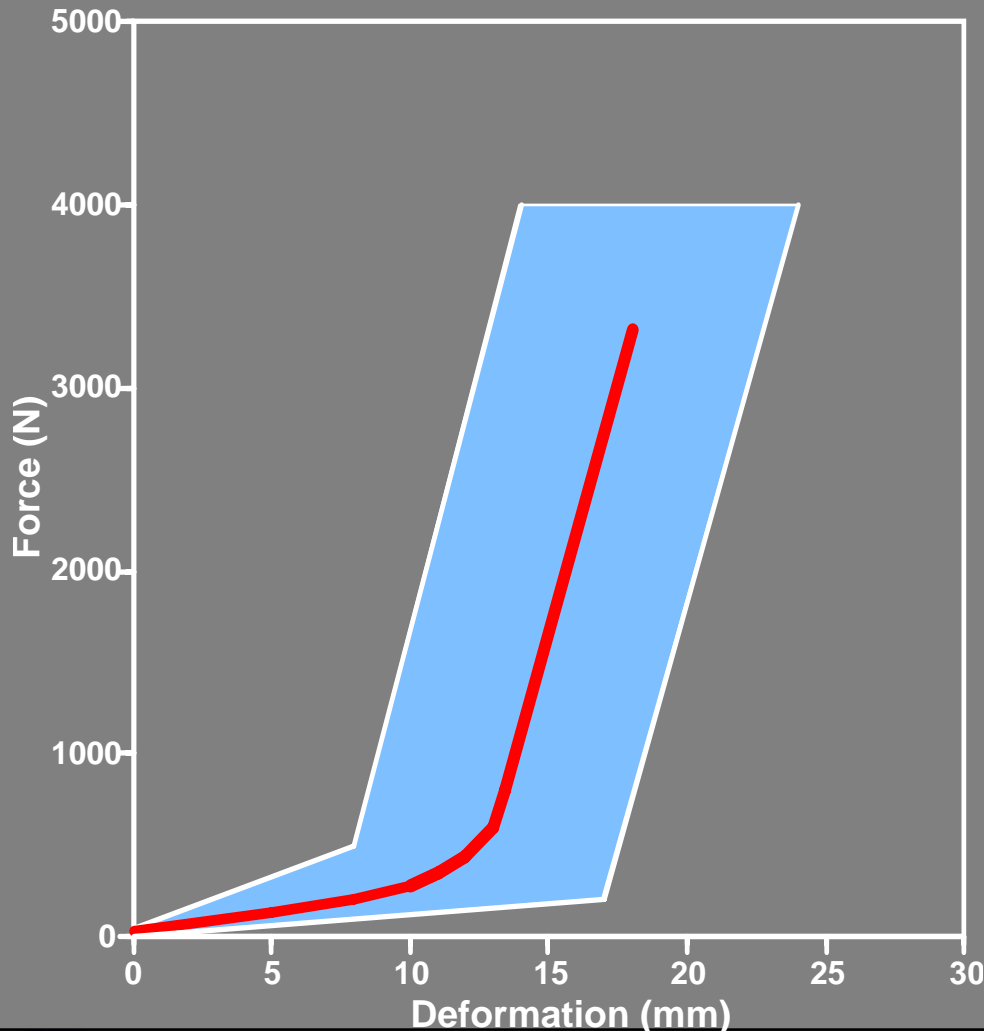
Injuries



Dynamic Axial Loading to the Head

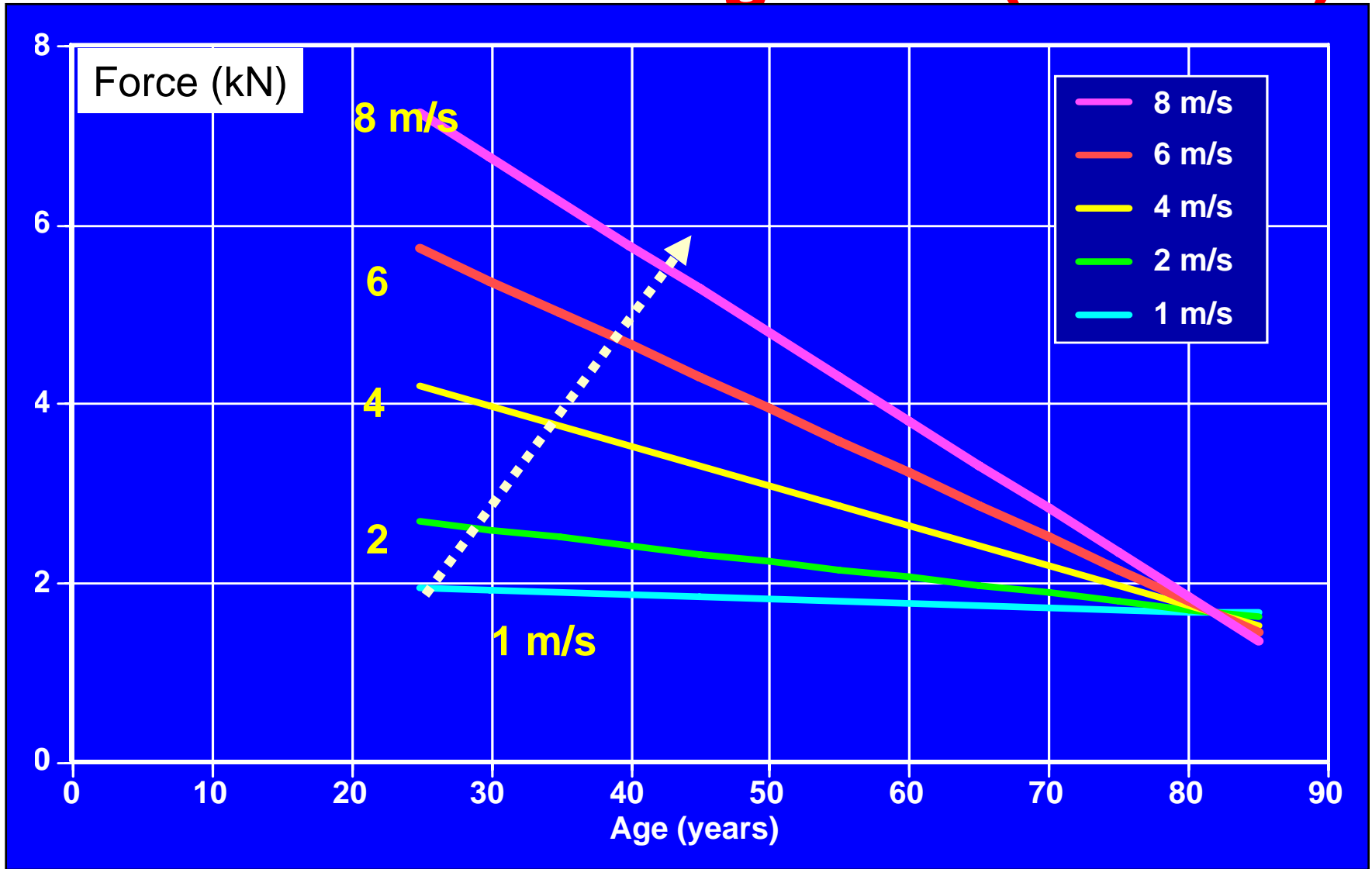


Compressive Force-Induced Trauma



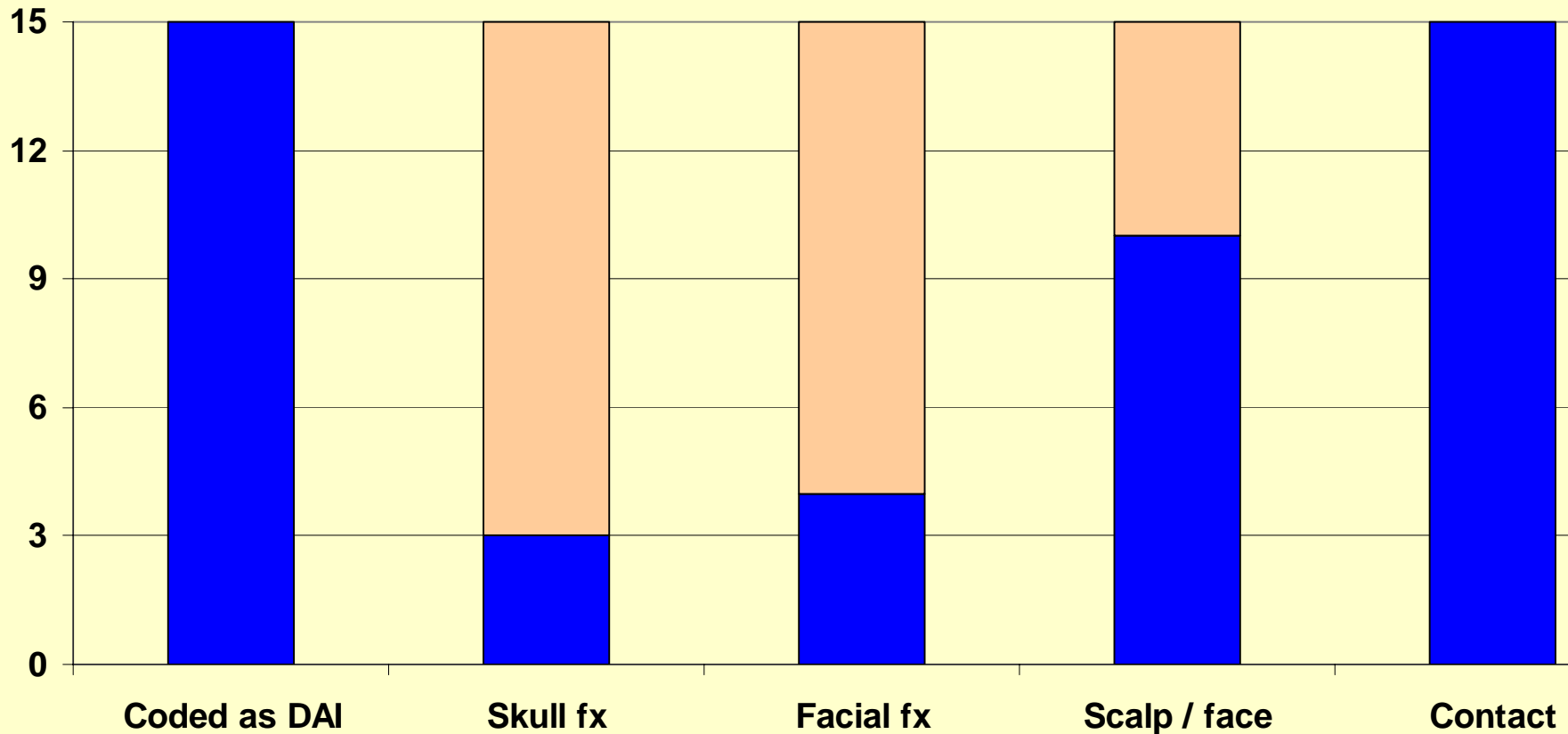
- **Sample size = 30**
- **Force : 3.5 ± 1.5 kN**
- **Deflection: 19 ± 3 mm**
- **29 to 95 years of age**

Effect of Loading Rate (Female)

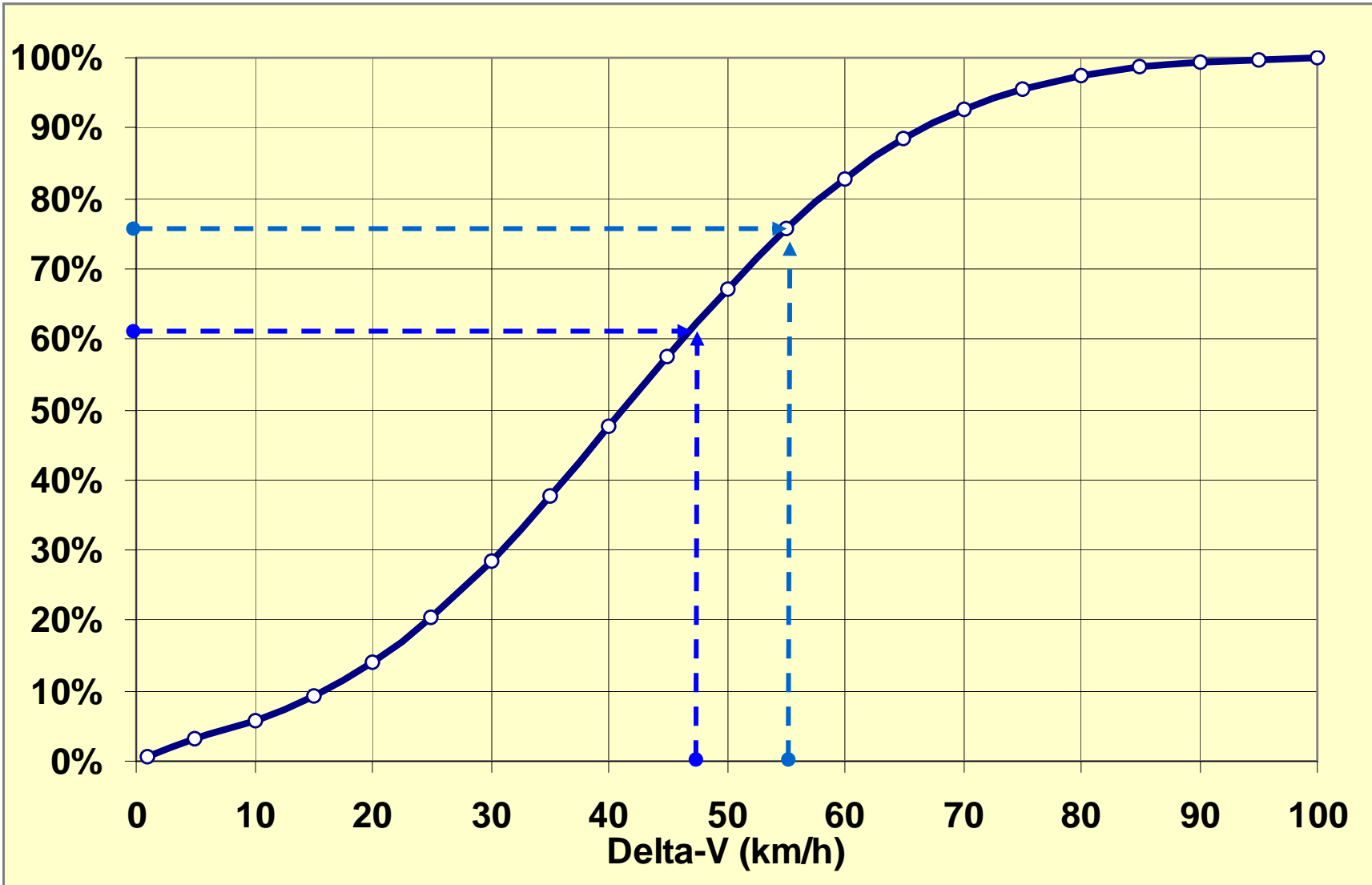


Injury Analyses: Frontal Impact

of cases

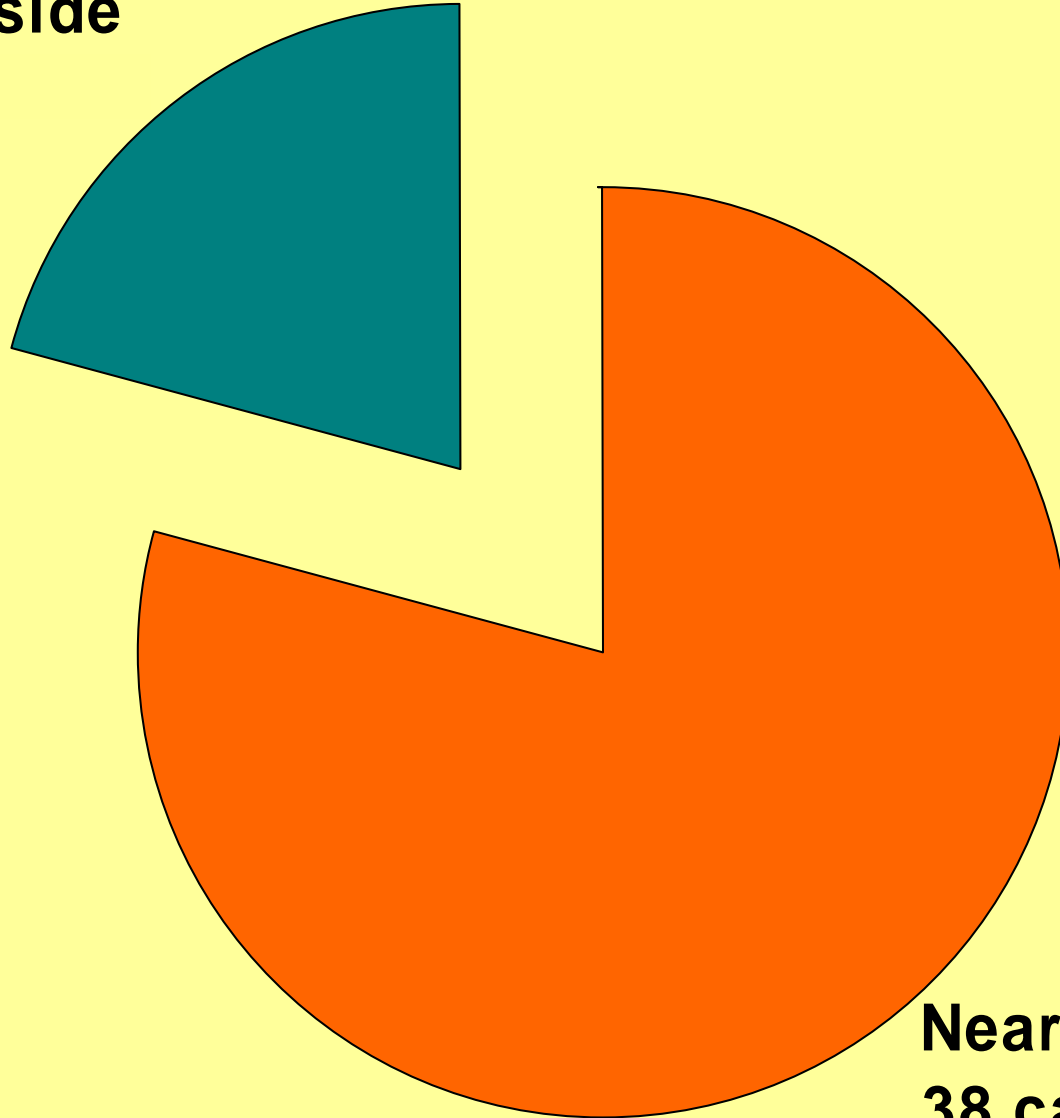


Cumulative Frequency Distribution



Side Impact Type

Farside

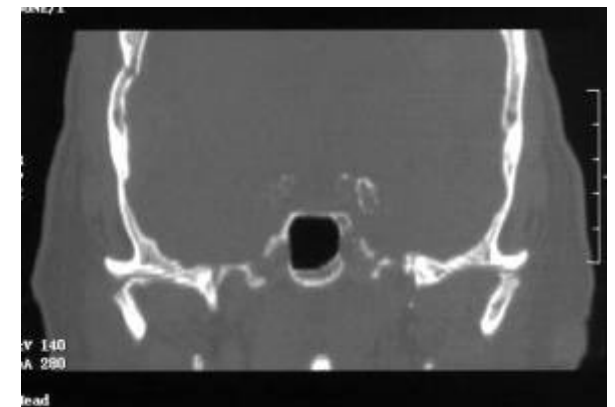
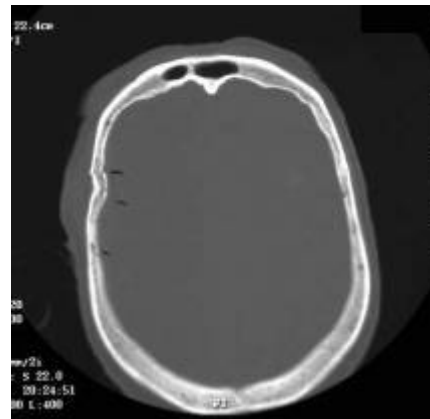
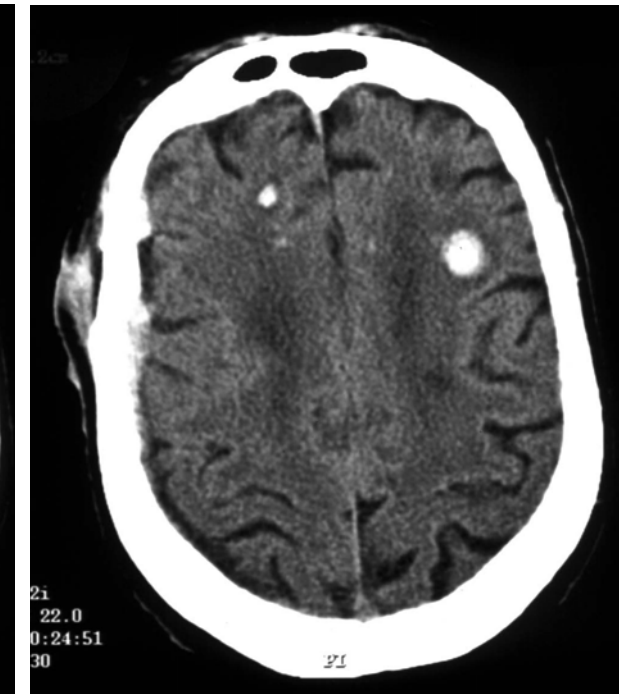


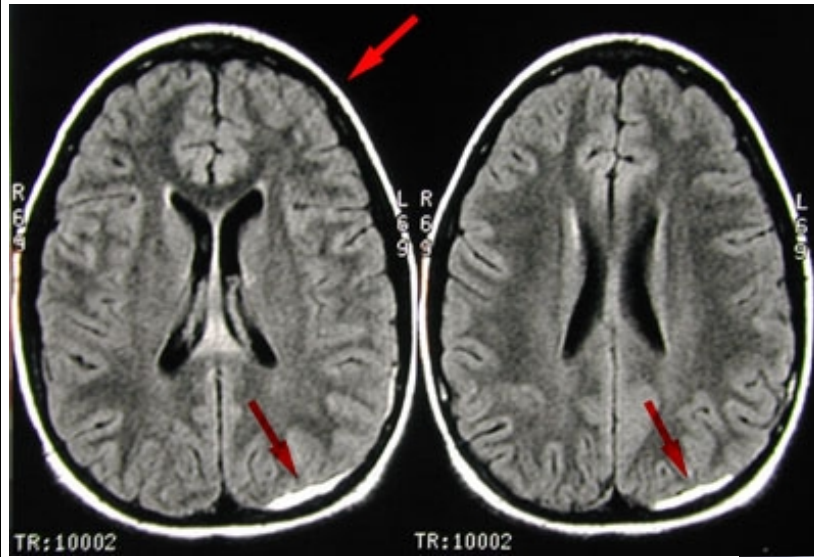
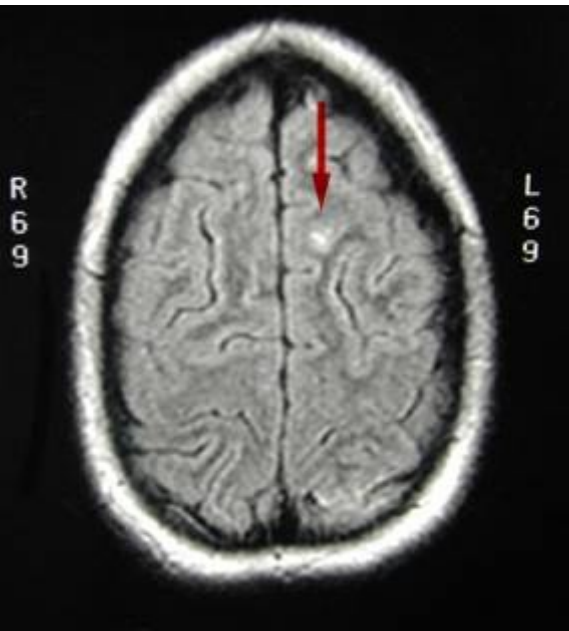
Nearside
38 cases

Only Brain Injuries



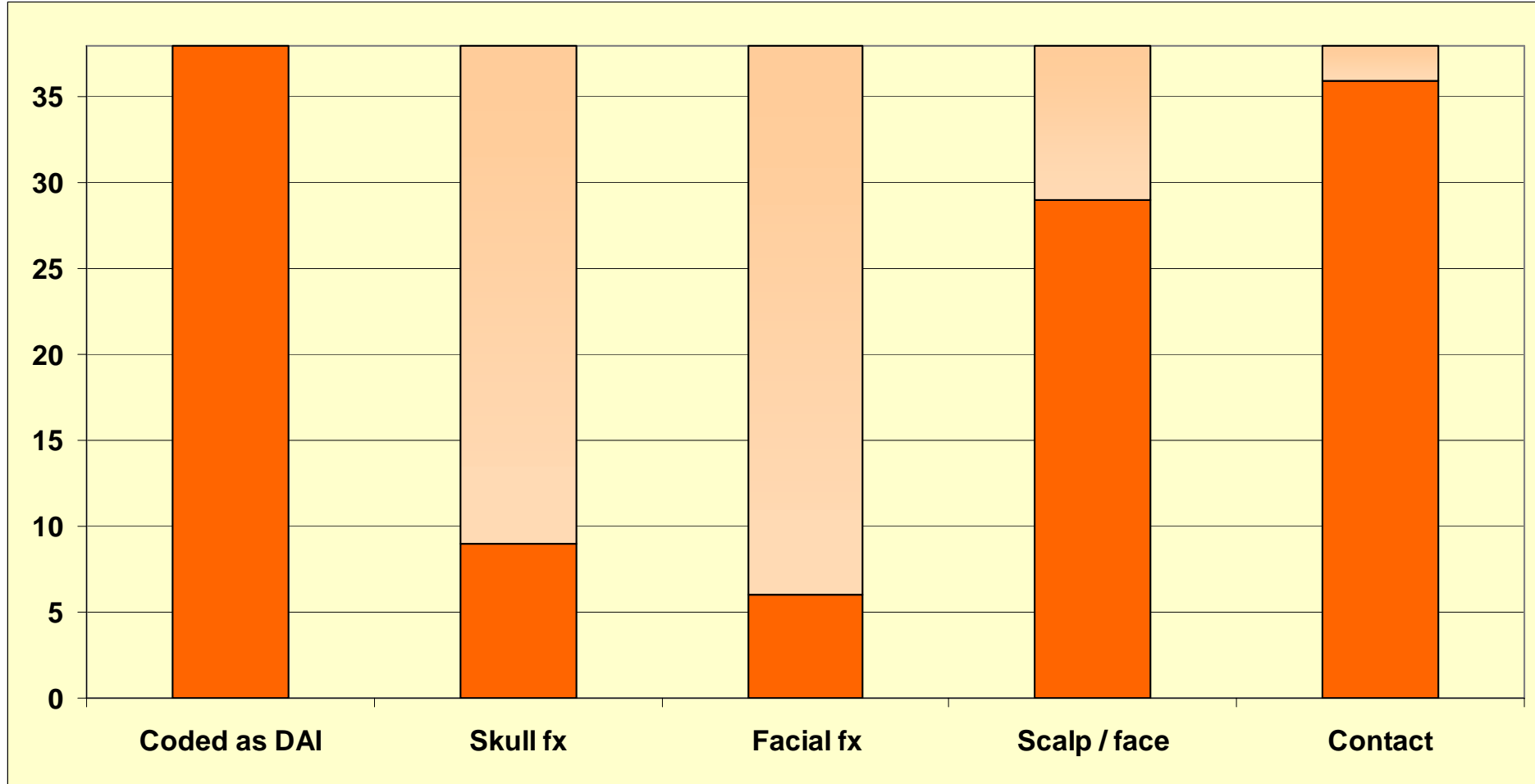
Associated Injuries





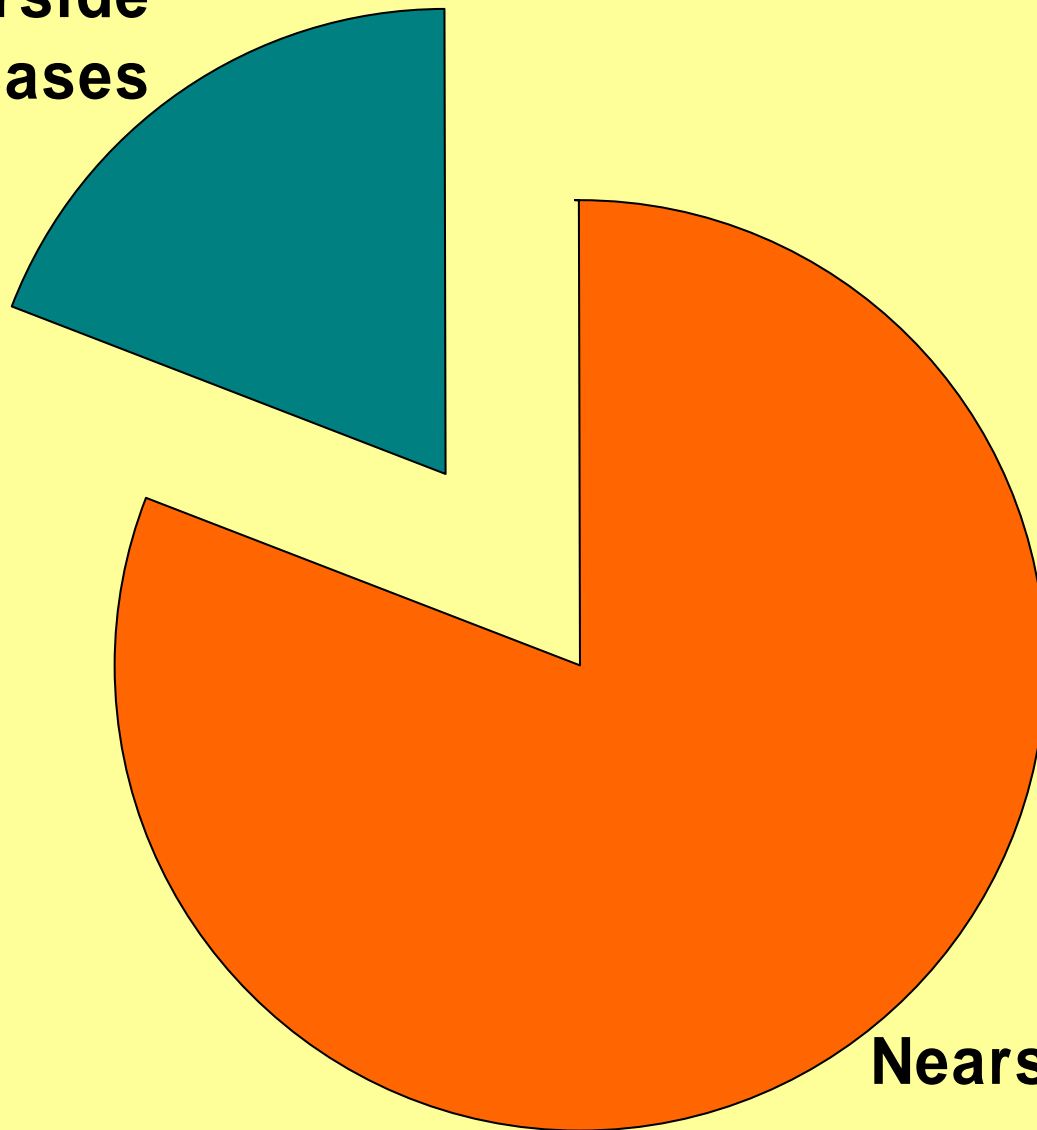
Injury Analyses: Nearside Impact

of cases



Side Impact Type

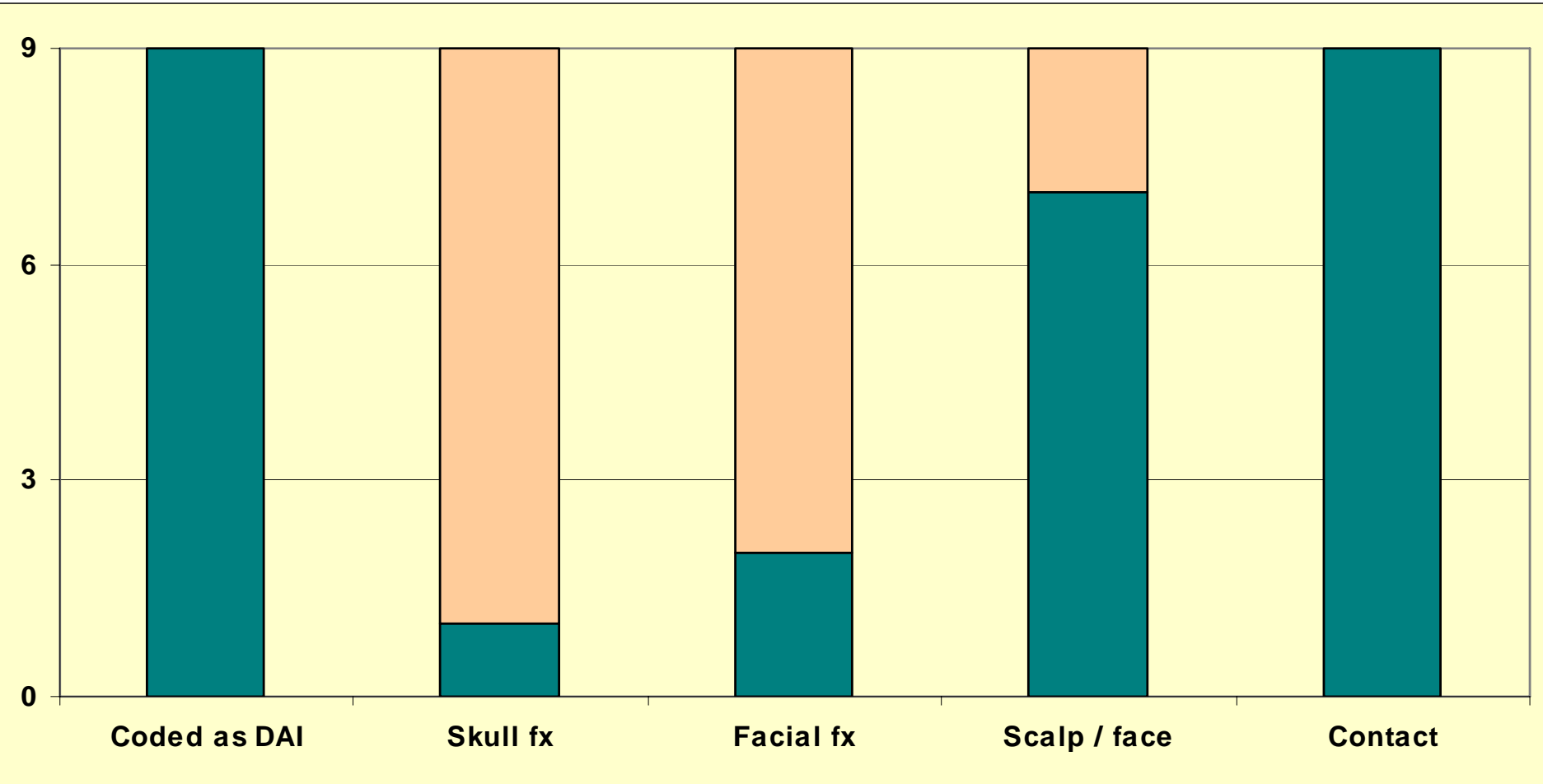
Farside
9 cases



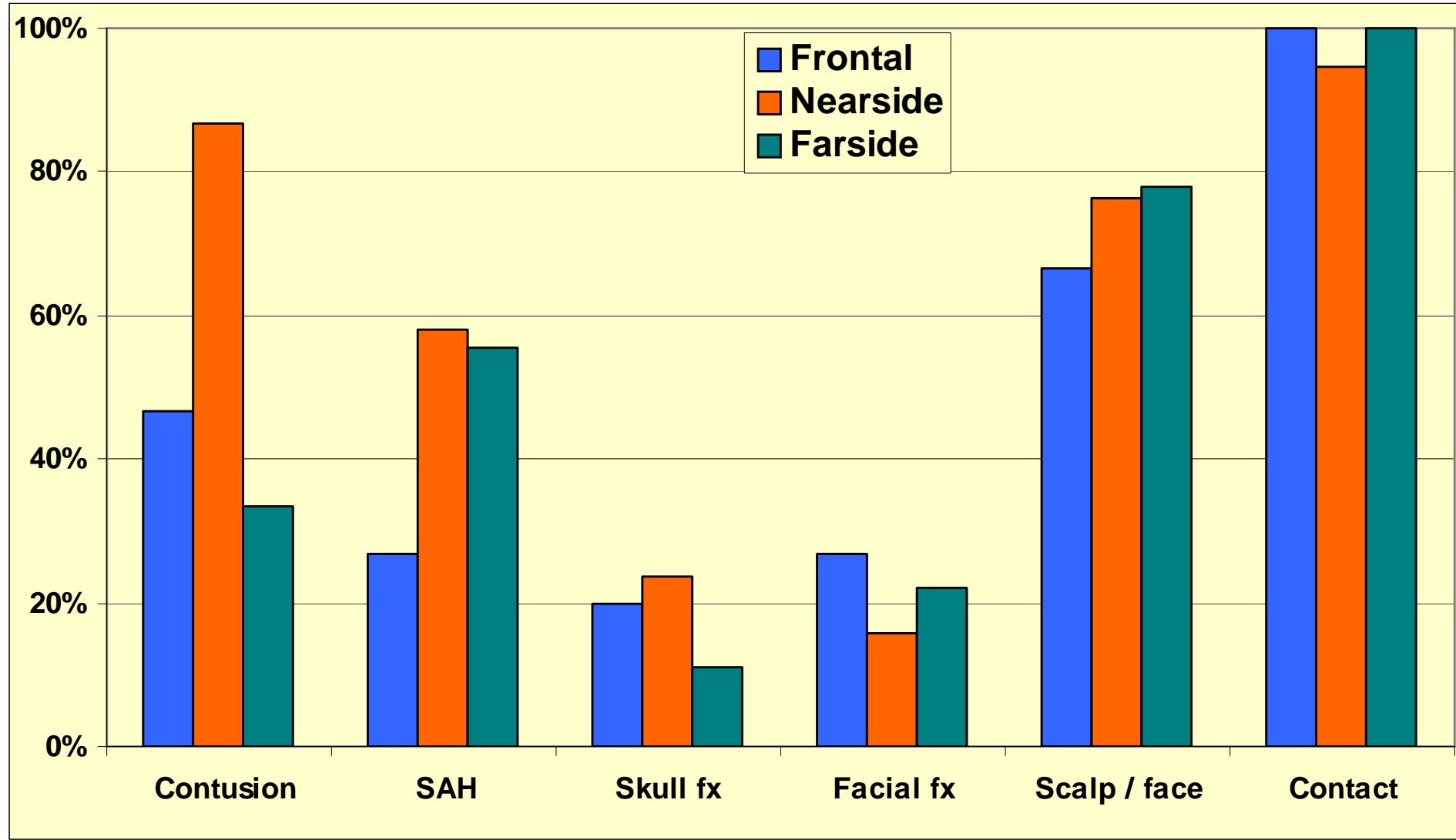
Nearside

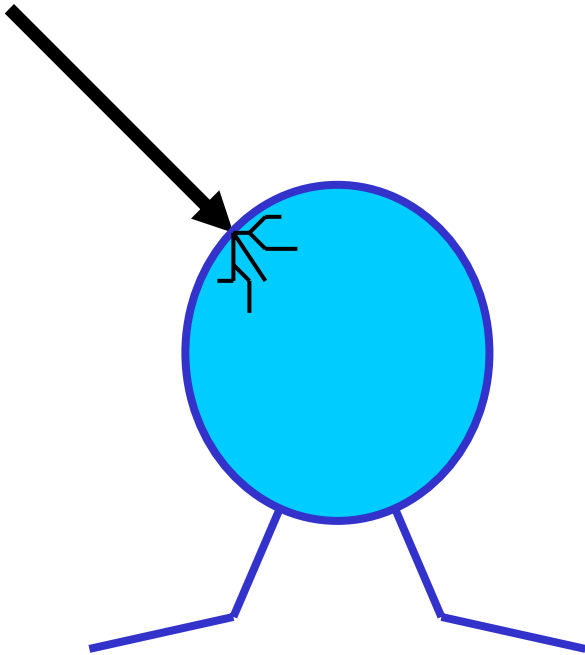
Injury Analyses: Far-side Impact

of cases

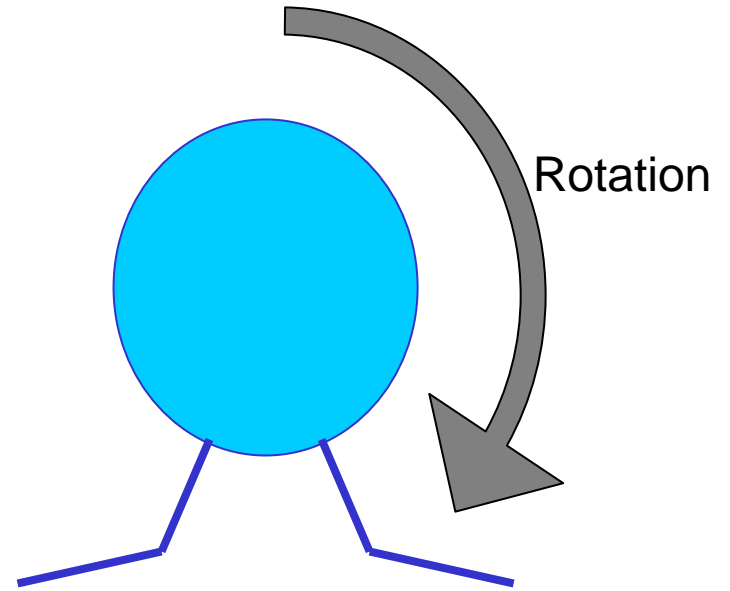


Comparison by Mode





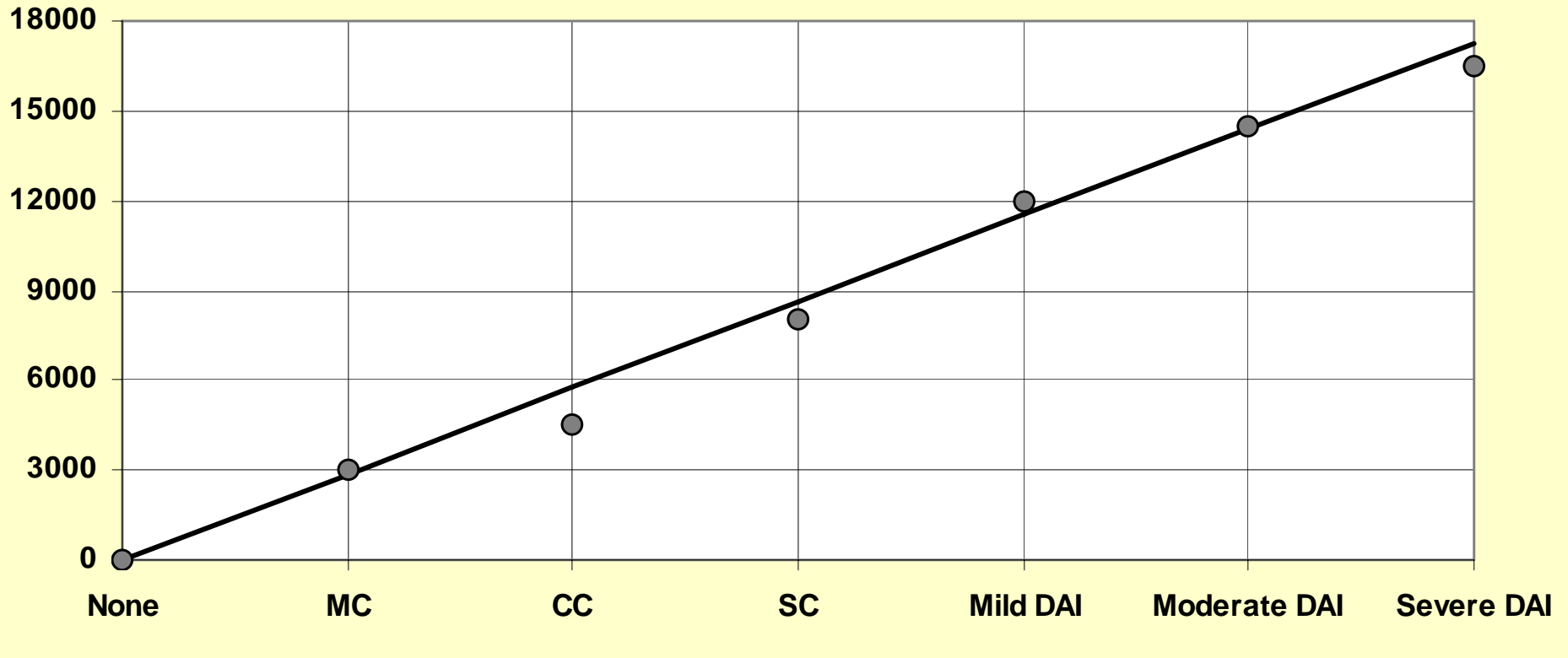
Focal injuries



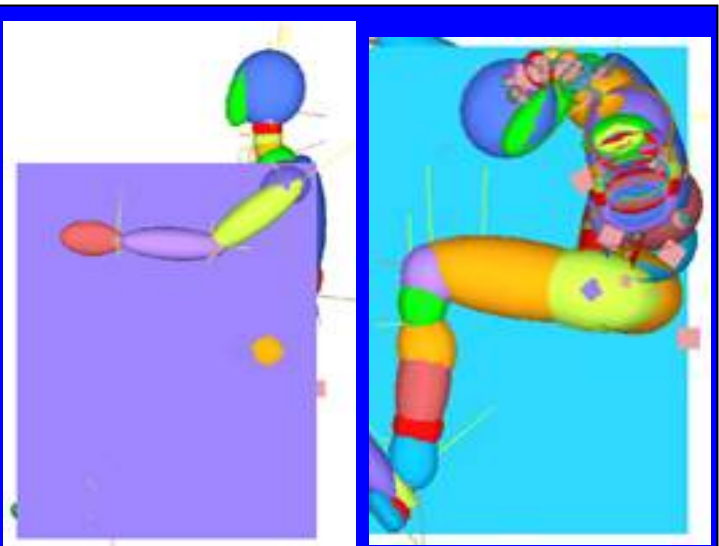
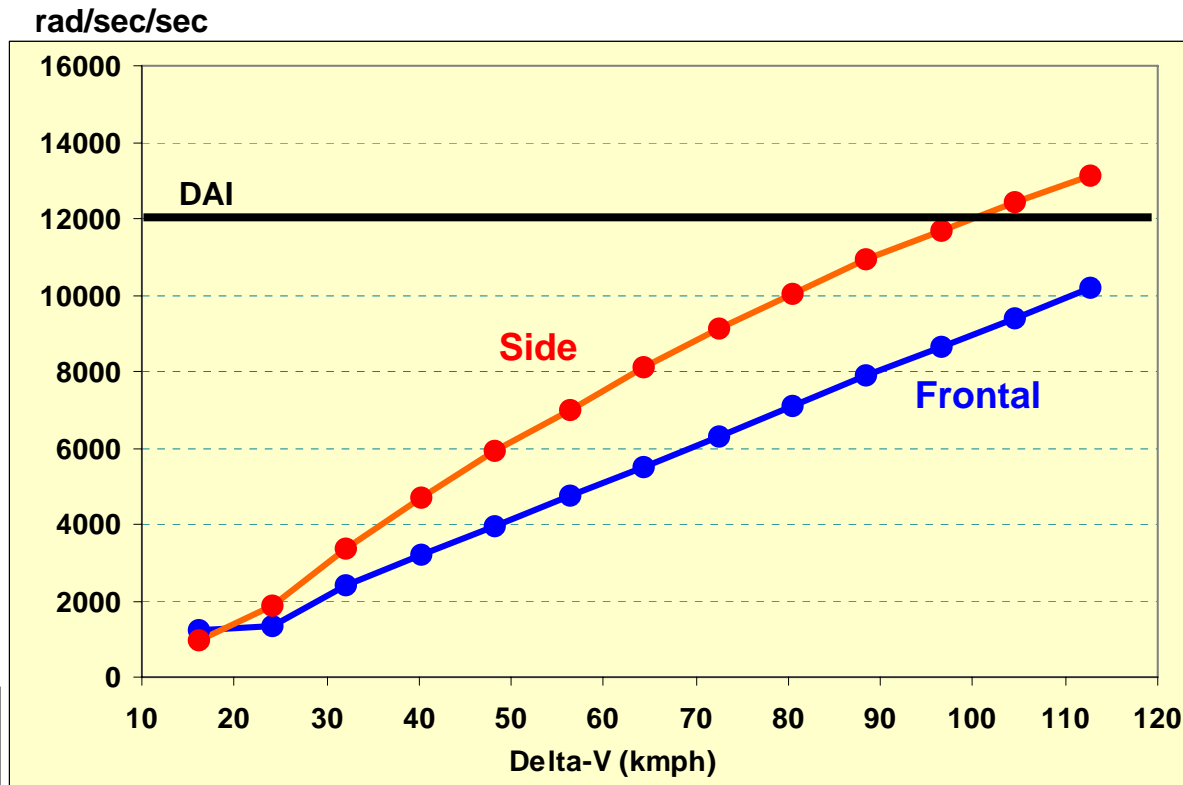
Motion injuries

Rotational Acceleration-Induced Brain Injury

rad/s²



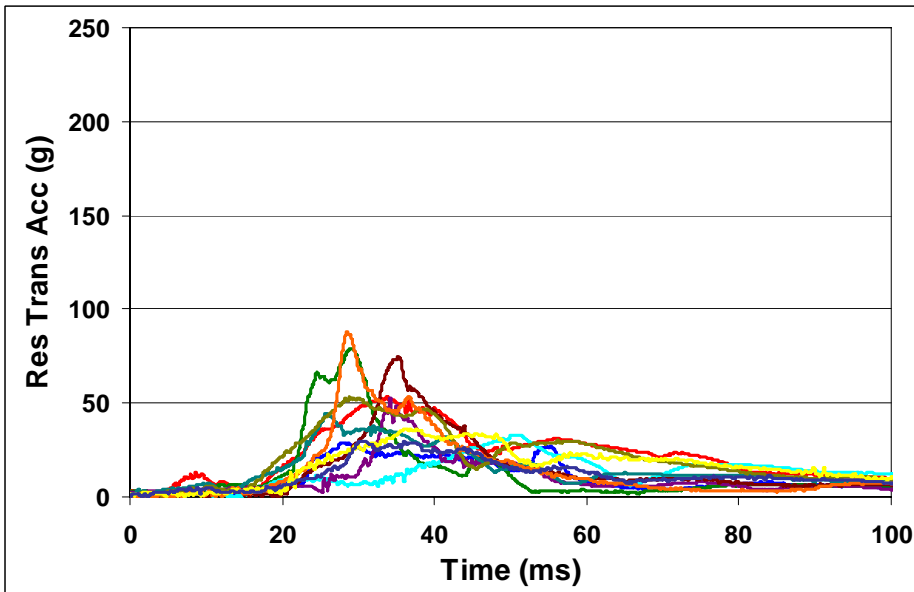
Noncontact Loading



LINCAP Tests

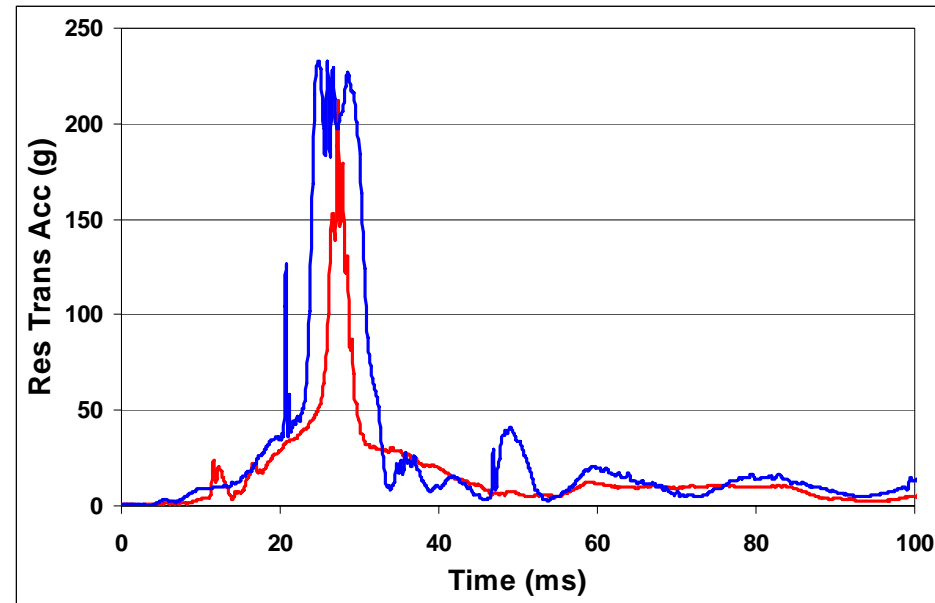
Linear Acceleration (g)

No Head Contact



HIC < 1000

Head Contact



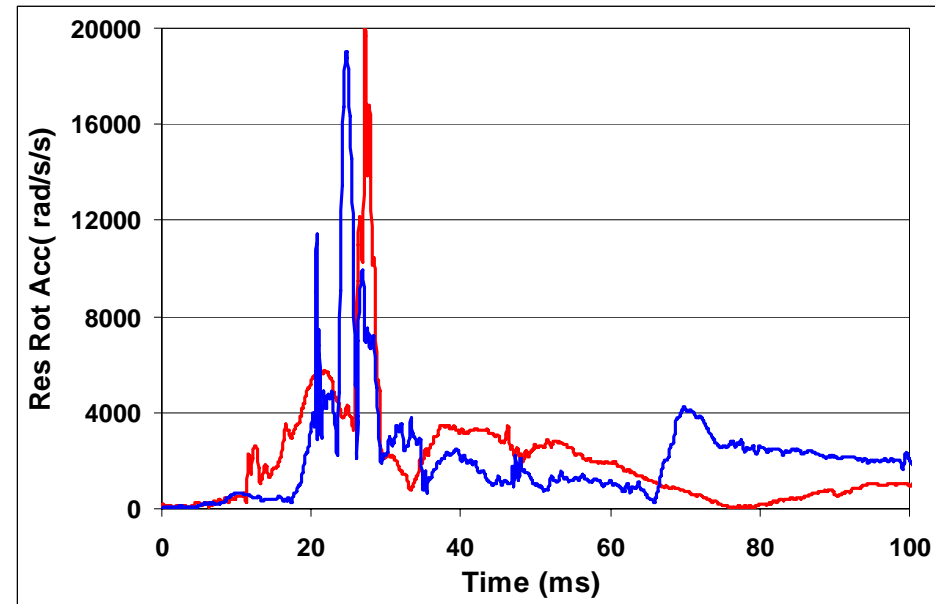
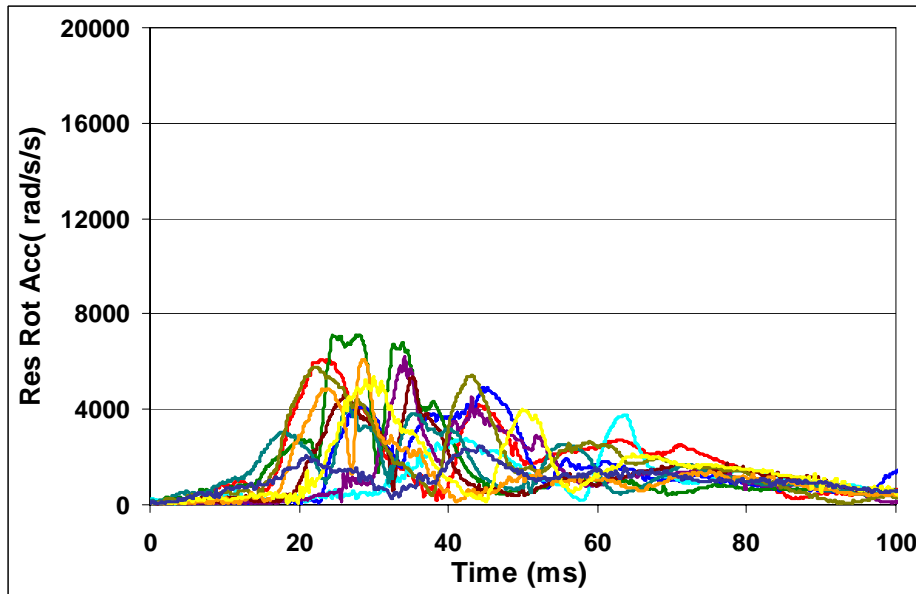
HIC: 712, 3986

LINCAP Tests

Angular Acceleration (rad/s/s)

No Head Contact

Head Contact



Summary

- **Used CIREN 1997-2006 database**
- **66 cases coded-DAI, AIS 1990/98**
- **Side impacts predominate, >70%**
- **Pediatric to geriatric age groups**
- **Skull/face involved > 90% cases**
- **Head contact association exists**
 - Images, clinical reports, & other BR (face, neck)
- **NCAP tests & laboratory studies**
 - contact-induced metrics

Acknowledgment

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